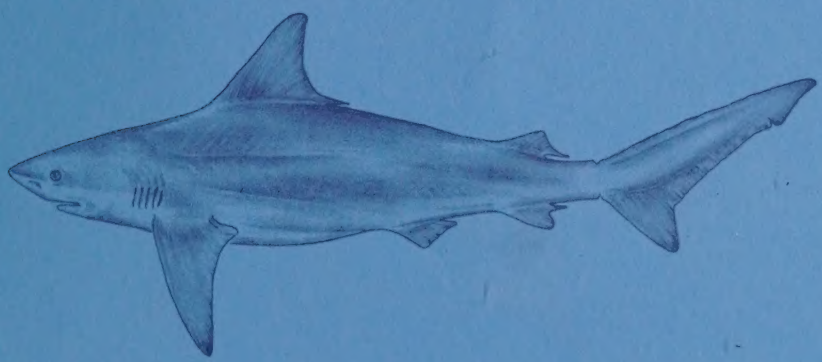
U.S. Department
of Commerce

August 2001
(revised November 2001)

NOAA Technical Report NMFS 153
A Scientific Paper of the **FISHERY BULLETIN**

Field Guide to Requiem Sharks (Elasmobranchiomorphi: Carcharhinidae) of the Western North Atlantic



Mark Grace

OAA
ech.
ept.
MFS
o.153
.1

U.S. Department of Commerce

Donald L. Evans
Secretary

National Oceanic and Atmospheric Administration

Scott B. Gudes
Acting Under Secretary for Oceans and Atmosphere

National Marine Fisheries Service

William T. Hogarth
Assistant Administrator for Fisheries

The *NOAA Technical Report NMFS* (ISSN 0892-8908) series is published by the Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Seattle, WA 98115-0070.

The Secretary of Commerce has determined that the publication of this series is necessary in the transaction of the public business required by law of this Department. Use of funds for printing of this series has been approved by the Director of the Office of Management and Budget.

NOAA Technical Reports NMFS

Scientific Papers of the **Fishery Bulletin**

Scientific Editor
Dr. John V. Merriner

Editorial Assistant
Sarah Shoffler

Center for Coastal Fisheries and Habitat Research, NOS
101 Pivers Island Road
Beaufort, North Carolina 28516

Managing Editor
Shelley Arenas
Scientific Publications Office
National Marine Fisheries Service, NOAA
7600 Sand Point Way N.E.
Seattle, Washington 98115-0070

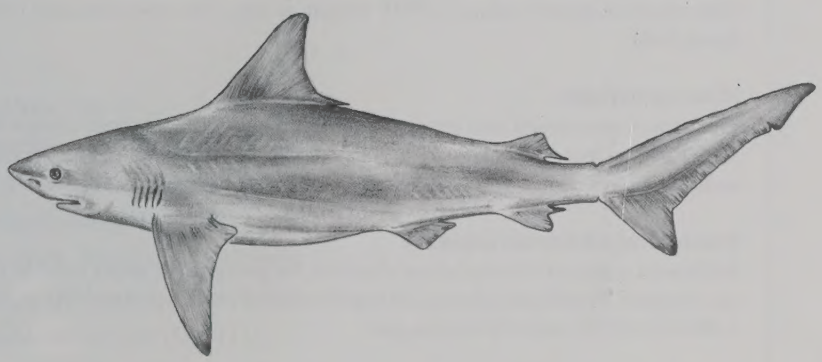
Editorial Committee
Dr. Andrew E. Dizon National Marine Fisheries Service
Dr. Linda L. Jones National Marine Fisheries Service
Dr. Richard D. Methot National Marine Fisheries Service
Dr. Theodore W. Pietsch University of Washington
Dr. Joseph E. Powers National Marine Fisheries Service
Dr. Tim D. Smith National Marine Fisheries Service

The *NOAA Technical Report NMFS* series of the *Fishery Bulletin* carries peer-reviewed, lengthy original research reports, taxonomic keys, species synopses, flora and fauna studies, and data- intensive reports on investigations in fishery science, engineering, and economics. The series was established in 1983 to replace two subcategories of the Technical Report series: "Special Scientific Report—Fisheries" and "Circular." Copies of the NOAA Technical Report NMFS are available free in limited numbers to government agencies, both federal and state. They are also available in exchange for other scientific and technical publications in the marine sciences. Reports are published online in PDF format at http://spo.nwr.noaa.gov.

NMFS Honolulu Library
00000000004883

NOAA Technical Report NMFS 153
A Scientific Paper of the *Fishery Bulletin*

Field Guide to Requiem Sharks (Elasmobranchiomorphi: Carcharhinidae) of the Western North Atlantic



Mark Grace

August 2001
(revised November 2001)

U.S. Department of Commerce
Seattle, Washington

Suggested reference
Grace, Mark. 2001. Field guide to requiem sharks (Elasmobranchiomorphi: Carcharhinidae) of the Western North Atlantic. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 153, 32 p.

Online dissemination
This report is posted online in PDF format at http://spo.nwr.noaa.gov (click on *Technical Reports* link).

Note on revision
This report was revised and reprinted in November 2001 to correct several errors. Previous copies of the report, dated August 2001, should be destroyed as this revision replaces the earlier version.

Purchasing additional copies
Additional copies of this report are available for purchase in paper copy or microfiche from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; 1-800-553-NTIS; http://www.ntis.gov.

Copyright law
Although the contents of the Technical Reports have not been copyrighted and may be reprinted entirely, reference to source is appreciated.

Proprietary products
The National Marine Fisheries Service (NMFS) does not approve, recommend, or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends, or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

CONTENTS

Introduction 1
Methods 1
Morphological features of Carcharhinidae (Fig. 1) 3
Western North Atlantic Ocean (Fig. 2) 4
General description of Carcharhinidae 5
Separation sheet for *Carcharhinus* species without an interdorsal ridge (Fig. 3) 6
Separation sheet for *Carcharhinus* species with an interdorsal ridge (Fig. 4) 7
Using the guide 8
Discussion 8
Key to Carcharhinidae 9
Species accounts
- Blue shark, *Prionace glauca* (Fig. 5) 10
- Tiger shark, *Galeocerdo cuvier* (Fig. 6) 11
- Lemon shark, *Negaprion brevirostris* (Fig. 7) 12
- Brazilian sharpnose shark, *Rhizoprionodon lalandii* (Fig. 8) 13
- Caribbean sharpnose shark, *Rhizoprionodon porosus* (Fig. 9) 14
- Atlantic sharpnose shark, *Rhizoprionodon terraenovae* (Fig. 10) 15
- Smalltail shark, *Carcharhinus porosus* (Fig. 11) 16
- Daggernose shark, *Isogomphodon oxyrhynchus* (Fig. 12) 17
- Oceanic whitetip shark, *Carcharhinus longimanus* (Fig. 13) 18
- Bull shark, *Carcharhinus leucas* (Fig. 14) 19
- Blacknose shark, *Carcharhinus acronotus* (Fig. 15) 20
- Finetooth shark, *Carcharhinus isodon* (Fig. 16) 21
- Blacktip shark, *Carcharhinus limbatus* (Fig. 17) 22
- Spinner shark, *Carcharhinus brevipinna* (Fig. 18) 23
- Sandbar shark, *Carcharhinus plumbeus* (Fig. 19) 24
- Bignose shark, *Carcharhinus altimus* (Fig. 20) 25
- Night shark, *Carcharhinus signatus* (Fig. 21) 26
- Galapagos shark, *Carcharhinus galapagensis* (Fig. 22) 27
- Dusky shark, *Carcharhinus obscurus* (Fig. 23) 28
- Reef shark, *Carcharhinus perezi* (Fig. 24) 29
- Silky shark, *Carcharhinus falciformis* (Fig. 25) 30

Acknowledgments 31
Literature cited 31

Abstract—Identification problems are common for many sharks due to a general lack of meristic characteristics that are typically useful for separating species. Other than number of vertebrae and number and shape of teeth, identifications are frequently based on external features that are often shared among species. Identification problems in the field are most prevalent when live specimens are captured and releasing them with a minimum of stress is a priority (e.g., shark tagging programs). Identifications must be accurate and conducted quickly but this can be challenging, especially if specimens are very active or too large to be landed without physical damage. This field guide was designed primarily for use during field studies and presents a simplified method for identifying the 21 species of western North Atlantic Ocean sharks belonging to the family Carcharhinidae (carcharhinids). To assist with identifications a dichotomous key to Carcharhinidae was developed, and for the more problematic *Carcharhinus* species (12 species), separation sheets based on important distinguishing features were constructed. Descriptive text and illustrations provided in the species accounts were developed from field observations, photographs, and published references.

Field Guide to Requiem Sharks (Elasmobranchiomorphi: Carcharhinidae) of the Western North Atlantic

Mark Grace
Mississippi Laboratories
Southeast Fisheries Science Center
NOAA, National Marine Fisheries Service
P.O. Drawer 1207
Pascagoula, Mississippi 39568-1207
Email: Mark.A.Grace@noaa.gov

Introduction

Carcharhinids are distributed throughout temperate and tropical oceans with several species occurring worldwide. Habitats are oceanic beyond the continental shelf (oceanic whitetip sharks, *Carcharhinus longimanus*) and inland into freshwater rivers and lakes (bull sharks, *Carcharhinus leucas*). Some species tend to associate with bottom while others range throughout the water column. All carcharhinids are viviparous or ovoviviparous (Compagno, 1984). Carcharhinid sharks are a valuable resource worldwide. They are utilized for their flesh, fins, oil, and skin, and are taken recreationally (Bonfil, 1994). Some species are known to travel long distances, occasionally crossing oceans, and are considered to be a resource shared between regions and nations.

Carcharhinidae genera can be difficult to identify due to similar body shape, color, and overlapping distributions; particularly *Carcharhinus* species and *Rhizoprionodon* species. There are a number of shark identification keys and field guides that are invaluable for carcharhinid identifications and those works are fundamental for providing a format for accurate identifications (Bigelow and Schroeder, 1948; Baughman and Springer, 1950; Springer, 1950; Casey, 1964; Clark and von Schmidt, 1965; Schwartz and Burgess, 1975; Hoese and Moore, 1977; Boschung, 1979; Garrick, 1982, 1985; Castro, 1983; Compagno, 1984; Garman, 1997; McEachran and Fechhelm, 1998). Existing literature generally includes many shark genera or addresses world-wide distributions and life history information that may not be applicable to carcharhinids of the western North Atlantic Ocean. This field guide is unique in that it addresses only carcharhinids from the western North Atlantic Ocean.

Methods

Information presented in this field guide was gathered during field investigations (most notably: Grace[1–6], Mitch-

[1] Grace, M. 1995. Cruise results for OREGON II 95-04 (218), coastal shark survey. U.S. Gulf of Mexico, survey depths 18 m–73 m. NMFS Mississippi Laboratories cruise report, 19 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

[2] Grace, M. 1996. Cruise results for OREGON II 96-04 (222), coastal shark survey. U.S. Gulf of Mexico and Atlantic seaboard from Florida to Cape Ann, MA, survey depths 18 m–73 m. NMFS Mississippi Laboratories cruise report, 12 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

[3] Grace, M. 1997. Cruise results for OREGON II 97-04 (227), MEXUS–GULF coastal shark survey. Mexican and U.S. Gulf of Mexico from Cabo Rojo, Mexico to Florida, and the U.S. Atlantic seaboard from Florida to Cape Hatteras, NC, survey depths 9 m–55 m. NMFS Mississippi Laboratories cruise report, 15 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

[4] Grace, M. 1998. Cruise results for OREGON II 98-02 (231), MEXUS–GULF, US–Cuba and

continued

ell[7], and Natanson[8,9]), and from reviews of published references. For species not examined in the laboratory or encountered during field investigations (Brazilian sharpnose shark, *Rhizoprionodon lalandii*; Caribbean sharpnose shark, *Rhizoprionodon porosus*; daggernose shark, *Isogomphodon oxyrhynchus*; Galapagos shark, *Carcharhinus galapagensis*), species accounts and illustrations were developed from published literature. The guide's format emphasizes external distinguishing features important for separating carcharhinids during field studies. Species descriptions, maximum size, distribution information, and illustrations are provided for all carcharhinid species. Diagrammatic species separation sheets based on important distinguishing features are provided for 12 species of the more problematic *Carcharhinus* species. Species separation sheets provide a graphic format that can be quickly referenced for determining important distinguishing features needed in the field. The guide is written primarily for field biologists, but fishermen and naturalists may find the guide useful.

The order for species accounts follows the dichotomous key to Carcharhinidae or the diagrammatic species separation sheets and does not represent carcharhinid phylogeny. Descriptions of morphological features (Fig. 1), size ranges, distribution, and illustrations of adults accompany each species account. Tooth shape is described for the 3–6 upper teeth, on either side of the upper jaw midpoint, excluding the rudimentary 1–2 center upper teeth. Teeth are redrawn from Garrick (1982) unless otherwise noted. The equation for dental formulas is as follows: upper left–rudimentary center–upper right/ lower left–rudimentary center–lower right (e.g., 15–2–15/14–1–14). Dental formulas may include ranges or total counts for upper and lower teeth.

Illustrations were developed and drawn by the author from examination of specimens and photographs, and when necessary illustrations were adapted from or verified with examples from Bigelow and Schroeder (1948), Garrick (1982, 1985), Compagno (1984), and Garman (1997). Pectoral fins are illustrated depressed downward (generally not a natural position) to facilitate graphic representation of dorsal fin origin as related to the pectoral fin axil, pectoral fin inner margin, or pectoral fin inner corner. For several species illustrations, feature arrows indicate characteristics of particular importance for identifications. Vertical lines are superimposed on illustrations to depict the first dorsal fin origin in relation to the pectoral fin, and when applicable the second dorsal fin origin in relation to the anal fin.

Maximum sizes (total length, TL) included in this field guide were taken from published references; some references were used as a source for maximum size based on recommendations for data useful for population assessments (Cortes[10]). If current publications cited older references for maximum sizes, the original source is used in the species descriptions. Maximum size information is augmented with survey data for maximum sizes recorded during shark surveys (1995–1999) conducted by the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA/NMFS), Southeast Fisheries Science Center, Mississippi Laboratories. The NOAA/NMFS surveys encompassed continental shelf waters of the U.S. Gulf of Mexico, the Mexican Gulf of Mexico, the circumference of Cuba, the circumference of Navassa Island (a U.S. protectorate, Caribbean Sea) and the U.S. Atlantic seaboard from the Florida Keys to Cape Ann, MA (Grace[1–6], Mitchell[7], and Thompson[11]). Even though maximum sizes from NOAA/NMFS surveys (standardized gear and randomized survey design) can differ from what is found in published references, NOAA/NMFS maximum sizes are useful since they reflect what can be currently expected during surveys conducted in the western North Atlantic. The NOAA/NMFS maximum size information was compiled from Grace[1–6], Mitchell[7], and Thompson[11], and is cited in the species accounts as NMFS, n = number of specimens examined (e.g., NMFS, n = 123). Total length values were taken from actual measurements unless indicated as estimated (e.g., 123.0 cm TL estimated). Max-

[4] *(continued)*(Navassa Island coastal shark survey. Mexican Gulf of Mexico, survey depths 9 m–55 m; circumference of Cuba and Navassa Island, survey depths 27.2 m–412.8 m. NMFS Mississippi Laboratories cruise report, 26 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

[5] Grace, M. 1999. Cruise results for OREGON II 99-02 (233), Oculina Research Reserve and Atlantic coast shark survey (Ft. Pierce to Cape Canaveral, FL), survey depths 9 m–55 m. NMFS Mississippi Laboratories cruise report, 15 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

[6] Grace, M. 1999. Cruise results for CARETTA 99-01, north-central Gulf of Mexico coastal shark survey, survey depths 9 m–55 m. NMFS Mississippi Laboratories cruise report, 11 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

[7] Mitchell, K. 1999. Cruise results for FERREL 99-10-SEF, *Lutjanus campechanus* (red snapper) longline cruise. North-central Gulf of Mexico, survey depths 64 m–146 m. NMFS Mississippi Laboratories cruise report, 12 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

[8] Natanson, L. 1996. Cruise results for PELICAN 96-01 (1–3), survey of apex predators—sharks. NMFS Narragansett Laboratory cruise report, 13 p., 28 Tarzwell Dr., Narragansett, RI 02882-1199.

[9] Natanson, L. 1998. Cruise results for DELAWARE II 98-06 (1–3), survey of apex predators—sharks. NMFS Narragansett Laboratory cruise report, 28 Tarzwell Dr., Narragansett, RI 02882-1199.

[10] Cortes, E. 2000. NMFS Panama City Laboratory, 3500 Delwood Beach Rd., Panama City, FL, 32408. Personal commun.

[11] Thompson, P. 1995. Cruise results for RELENTLESS 95-03 (2). Coastal shark longline survey. U.S. Atlantic seaboard from Cape Canaveral, FL to Cape Hatteras, NC, survey depths 18 m–73 m, 8 p., P.O. Drawer 1207, Pascagoula, MS 39568-1207.

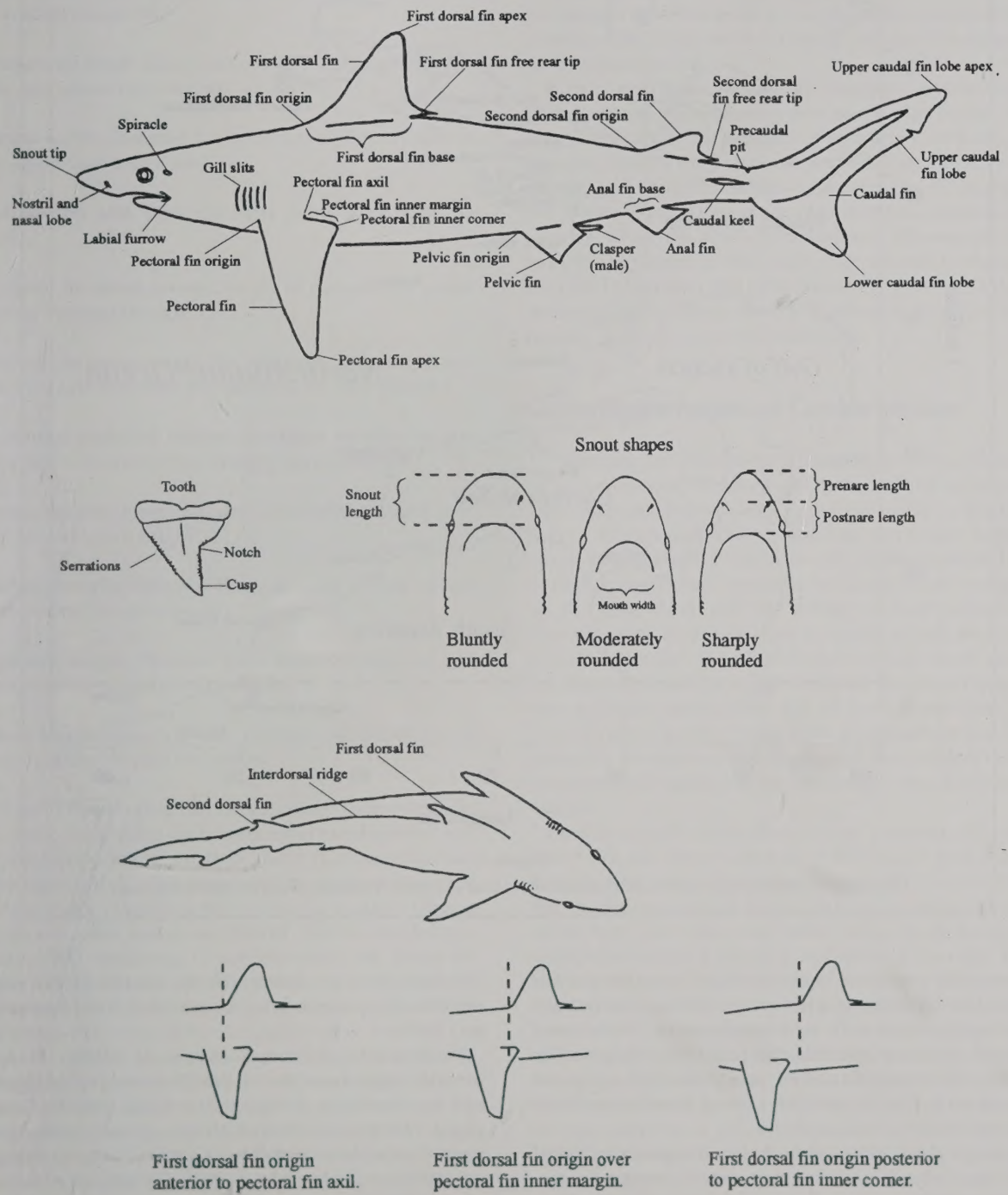


Figure 1

Morphological features and measurement reference points for Carcharhinidae.

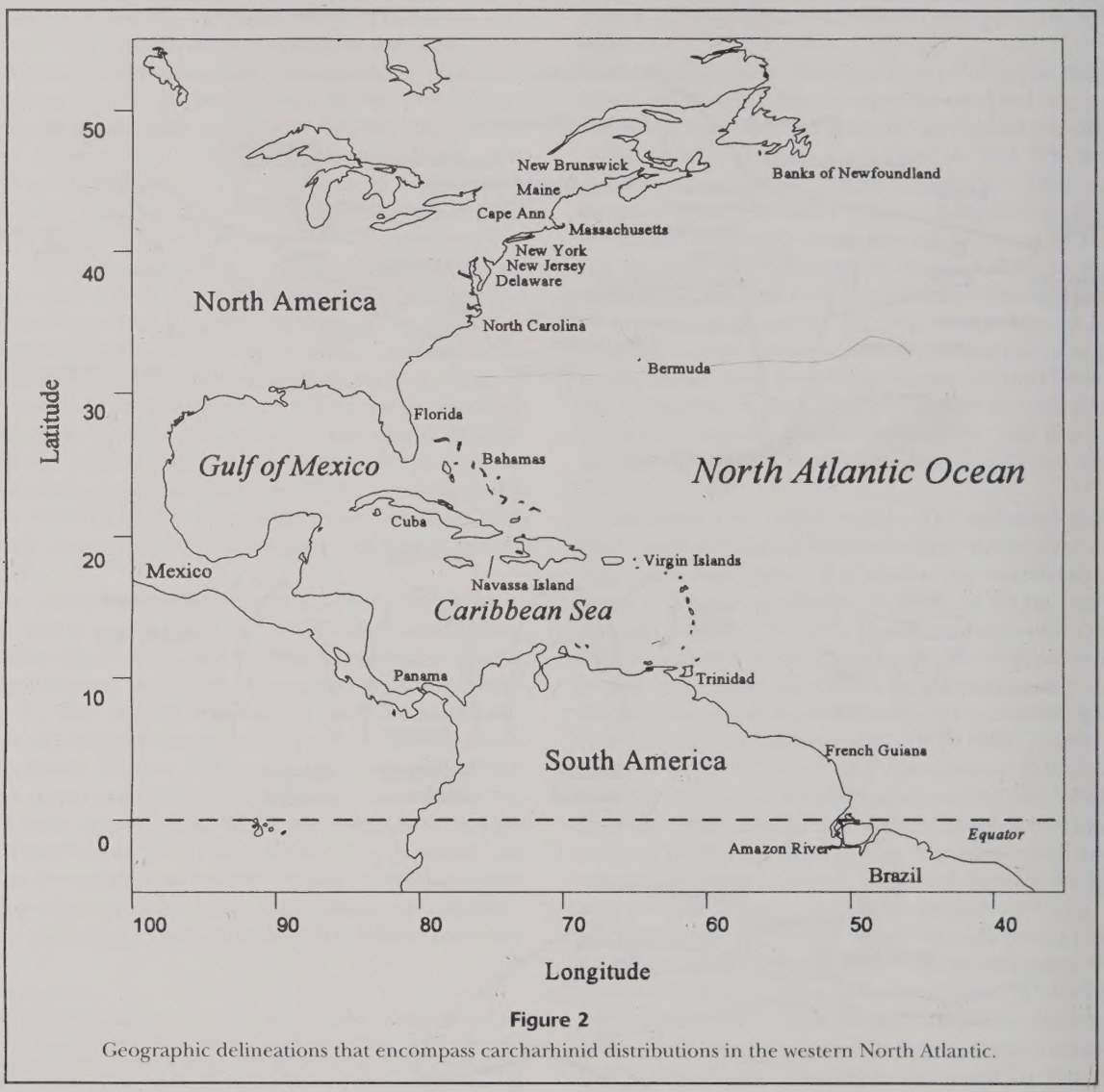


Figure 2

Geographic delineations that encompass carcharhinid distributions in the western North Atlantic.

imum sizes presented in this field guide are not intended as the definitive benchmark for each species but are included to assist with separating species. Guide users should be aware there is the possibility of capturing sharks exceeding maximum sizes presented and extra attention should be given for correct identification and documentation of those sharks.

Geographic delineations that encompass carcharhinid distributions in the western North Atlantic are the Banks of Newfoundland, Canada, for the northern limit; the equator at the mouth of the Amazon River, South America, for the southern limit; west of 40°W longitude to the extreme western coasts of the Gulf of Mexico and Caribbean Sea (Fig. 2). Unless otherwise cited, species distributions in the western North Atlantic Ocean provided in the species accounts were taken from Compagno (1984).

Nomenclature follows Robins et al. (1991) except for the daggernose shark, Brazilian sharpnose shark, and the Caribbean sharpnose shark which follow Compagno (1984). Exclusion of *Mustelus* (family Triakidae) from Carcharhinidae follows Castro (1983), Compagno (1984), and Heemstra (1997). Definitions of terms used in this guide are as follows:

Fin origin: Anterior most point of fin base of first dorsal fin, second dorsal fin, pectoral fins, pelvic fins, and anal fin.

First or second dorsal fin free rear tip: Trailing free rear tip originating posterior to fin base termination of first or second dorsal fin.

Interdorsal ridge: Raised narrow dermal ridge between first and second dorsal fins.

Mouth width: Distance between the mouth corners of the upper and lower jaw.

Pectoral fin axil: Posterior-most point of pectoral fin base.

Pectoral fin inner corner: Angle of pectoral fin posterior to pectoral fin axil.

Pectoral fin inner margin: Fin margin originating at pectoral fin axil continuing to pectoral fin inner corner.

Precaudal vertebral centra: Complete vertebral centra anterior to forward edge of upper precaudal pit.

Precaudal pit: Dorsal and ventral notches located anterior to caudal fin origin.

Prenare length: Distance from anterior origin of nostrils to anterior-most point of snout.

Postnare length: Distance from anterior origin of nostrils to anterior margin of mouth.

Snout length: Distance from anterior margin of mouth to anterior-most point of snout.

Carcharhinids that can be identified to species level by using the guide's dichotomous key include the oceanic whitetip shark, smalltail shark (*Carcharhinus porosus*), tiger shark (*Galeocerdo cuvier*), daggernose shark, lemon shark (*Negaprion brevirostris*), blue shark (*Prionace glauca*), and sharpnose sharks (*Rhizoprionodon* species). The remaining 12 carcharhinids are more difficult to identify to species due to their similarities. Characteristics that were found most useful for distinguishing the more difficult species were used as the basis for species separation sheets (Figs. 3 and 4). Distinguishing features chosen for separation sheets were those effective for grouping similar species. Some distinguishing features were not used in separation sheets because they were difficult or impractical to determine from live specimens (e.g., number of precaudal vertebral centra).

Identification of *Carcharhinus* species is facilitated by division into two groups (exclusive of the smalltail shark and oceanic whitetip shark); five without an interdorsal ridge (Fig. 3), and seven with an interdorsal ridge (Fig. 4). Further division of each group is dependent on the first dorsal fin origin in relation to the pectoral fin. Species determination is completed by creating other subgroups based on snout shape, pectoral fin shape, or fin pigmentation.

It can be difficult to identify *Rhizoprionodon* species based on external features alone and it may be necessary to determine the number of vertebral centra when possible. Values for precaudal and total vertebral centra are provided for *Rhizoprionodon* species (Compagno, 1984). The copper shark (*Carcharhinus brachyurus*) and the silver tip shark (*Carcharhinus albimarginatus*) were not included in this guide even though Compagno (1984) indicates their distribution is possible in the western North Atlantic Ocean; however, their presence has not been scientifically confirmed.

General description of Carcharhinidae

Members of Carcharhinidae are variously distinguished by the presence of precaudal pits; lack of spiracles (present on tiger sharks and occurring rarely on lemon sharks, Compagno, 1988); bladelike teeth with single cusps; first dorsal fin origin usually above pectoral fin or slightly posterior to pectoral fin inner corner (except on the blue shark with the dorsal fin base midpoint closer to pelvic fin origin than pectoral fin axil); second dorsal fin smaller than first dorsal fin and above anal fin (second dorsal fin and first dorsal fin almost equal size on lemon sharks); fifth gill slit over or posterior to pectoral fin origin; no fleshy keels along sides of caudal peduncle (except on tiger sharks and blue sharks); well-developed nictitating membrane along eye socket lower margin.

Freshly caught carcharhinids have a variety of body colors that are often muted color mixed with gray toñes dorsally, and pale yellow or white laterally or ventrally; the exception is the blue shark which is counter shaded brilliant blue above and white below. Juvenile tiger sharks have distinct mottling and vertical bars that often fade with age; Atlantic sharpnose sharks (*Rhizoprinodon terraenovae*) often have light spots along the body. Juveniles for most species have fins tipped dusky or black. Adults generally have dusky fin tips, however, in the western North Atlantic Ocean blacktip sharks (*Carcharhinus limbatus*) greater than 80.0 cm TL have black fin tips except for a pale or white anal fin (Branstetter, 1982); all fin tips are black on spinner sharks (*Carcharhinus brevipinna*) greater than 80 cm TL (Branstetter, 1982); oceanic whitetip sharks have white fin tips on the first dorsal fin, pectoral fin, and caudal fin.

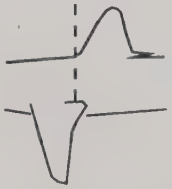
Sharks that may possibly be misidentified as belonging to Carcharhinidae include species of Odontaspididae (sand tiger sharks), and Lamnidae (mackerel

Carcharhinus species without an interdorsal ridge.

First dorsal fin origin anterior to or over pectoral fin axil.

- Snout moderately rounded. Long gill slits; length twice the eye diameter. Upper teeth narrow and finely serrated. Finetooth shark—*Carcharhinus isodon*,[1] Fig. 16.
- Snout bluntly rounded and short. Upper teeth broad and serrated. First dorsal fin high and triangular. Bull shark—*Carcharhinus leucas*, Fig. 14.

First dorsal fin origin over pectoral fin inner margin.



Fin tips dusky or not distinctly pigmented.

Pectoral fins short and broad.

- Snout moderately rounded; tip with dusky or black blotch. Upper teeth serrated and with distinct notch. Blacknose shark—*Carcharhinus acronotus*, Fig. 15.
- Snout moderately rounded; tip without dusky or black blotch. Long gill slits; length twice the eye diameter. Upper teeth narrow and not serrated or weakly serrated; without distinct notch. Finetooth shark—*Carcharhinus isodon*, Fig. 16.

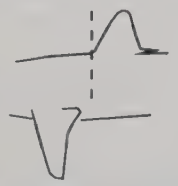
Pectoral fins long and broad.

- Snout bluntly rounded and short. First dorsal fin high and triangular. Upper teeth broad and serrated. Bull shark—*Carcharhinus leucas*,[2] Fig. 14.

Most fins with black tips.

- For specimens greater than 80 cm TL,[3] first dorsal fin, second dorsal fin, pectoral fins, and lower caudal fin lobe with distinct black tips;[4] anal fin white or pale. Dark chevron-shaped band along sides; originates near pectoral fin. Blacktip shark, *Carcharhinus limbatus*, Fig. 17.
- For specimens greater than 80 cm TL,[3] first dorsal fin, second dorsal fin, pectoral fins, anal fin, and lower caudal fin lobe with distinct black tips.[4] Often with a dark chevron-shaped band along sides; originates near pectoral fin. Spinner shark—*Carcharhinus brevipinna*,[5] Fig. 18.

First dorsal fin origin posterior to pectoral fin inner corner.



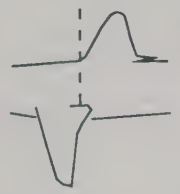
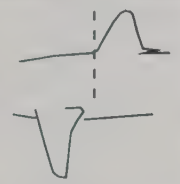
- Snout tip with dusky or black blotch. Blacknose shark—*Carcharhinus acronotus*,[1] Fig. 15.
- For specimens greater than 80 cm TL,[3] first dorsal fin, second dorsal fin, pectoral fins, anal fin, and lower caudal fin lobe with distinct black tips.[4] Spinner shark—*Carcharhinus brevipinna*, Fig. 18.

[1] First dorsal fin origin usually over pectoral fin inner margin. [2] First dorsal fin origin usually anterior to or over pectoral fin axil. [3] Refer to species descriptions for specimens less than 80 cm. [4] Fin tip pigmentation may be faded for larger specimens. [5] First dorsal fin origin usually posterior to pectoral fin inner corner.

Figure 3

Separation sheet for *Carcharhinus* species without an interdorsal ridge.

Carcharhinus species with an interdorsal ridge.

First dorsal fin origin anterior to or over pectoral fin axil.		Snout moderately or sharply rounded. First dorsal fin low with angular or slightly rounded apex. Prominent nasal lobes. Bignose shark—*Carcharhinus altimus*,[1] Fig. 20.
		Snout bluntly rounded. First dorsal fin high and triangular. Sandbar shark—*Carcharhinus plumbeus*, Fig. 19.
First dorsal fin origin over pectoral fin inner margin. 	**Snout long and moderately or sharply rounded.**	Prominent nasal lobes. Upper teeth long, moderately broad, symmetrical, and serrated. Bignose shark—*Carcharhinus altimus*, Fig. 20.
		Second dorsal fin free rear tip at least twice as long as second dorsal fin height. Upper teeth with distinct notch, oblique cusps and prominent basal serrations. Night shark—*Carcharhinus signatus*, Fig. 21.
	Snout bluntly rounded.	First dorsal fin high and triangular; origin usually closer to pectoral fin axil than pectoral fin inner margin midpoint. Pectoral fins broad. Sandbar shark—*Carcharhinus plumbeus*,[2] Fig. 19.
		First dorsal fin moderate with angular apex; origin closer to pectoral fin inner margin midpoint than pectoral fin inner corner. Pectoral fins broad. Usually found along oceanic islands. Galapagos shark—*Carcharhinus galapagensis*, Fig. 22.
		First dorsal fin usually low with sharply rounded apex; origin closer to pectoral fin inner corner than to pectoral fin inner margin midpoint. Pectoral fins tapered with falcate rear margin. Usually found along continental coastlines. Dusky shark—*Carcharhinus obscurus*, Fig. 23.
		First dorsal fin moderate with angular apex; origin closer to pectoral fin inner corner than to pectoral fin inner margin midpoint. Pectoral fins tapered and without falcate rear margin. Underside of pectoral fin tips, pelvic and anal fin tips, and lower caudal fin lobe tip often dusky or nearly black. Reef shark—*Carcharhinus perezi*, Fig. 24.
First dorsal fin origin posterior to pectoral fin inner corner. 		Pectoral fins without distinctly falcate rear margins. Snout is of moderate length and moderately rounded. Silky shark—*Carcharhinus falciformis*, Fig. 25.
		Pectoral fins with falcate rear margins. Snout bluntly rounded. Dusky shark—*Carcharhinus obscurus*,[1] Fig. 23.
		Pectoral fins without distinctly falcate rear margins. Snout long and sharply rounded. Upper teeth with distinct notch, oblique cusps, and prominent basal serrations. Night shark—*Carcharhinus signatus*,[1] Fig. 21.

[1] First dorsal fin origin usually over pectoral fin inner margin. [2] First dorsal fin origin usually anterior to or over pectoral fin axil.

Figure 4

Separation sheet for *Carcharhinus* species with an interdorsal ridge.

sharks): Members of these families have all five gill slits anterior to the pectoral fin origin; sand tiger sharks have short pectoral fins and large pelvic fins; mackerel sharks have lunate caudal fins (upper and lower caudal fin lobes of almost equal length) and well-developed caudal keels that extend past the caudal fin origin.

Using the guide

Once it is determined that a specimen is a species of Carcharhinidae, use the dichotomous key to Carcharhinidae to select the species or genus that represents the specimen, then refer to the appropriate species account or separation sheet. Prior to using the guide during field studies, familiarization with the dichotomous key is important for determining which species will not need to be identified by using separation sheets. This will save time for identifying the least problematic species and will allow direct referencing of separation sheets for the more problematic species. It is helpful to have copies of separation sheets included with on-deck sampling gear for quick referencing. Use the process of elimination to work through the separation sheets. Species that possess a diagnostic character that is variable will be listed more than once on the separation sheet. If identification characteristics presented on separation sheets are not discernible, the identification process should not proceed.

Species accounts include information pertaining to distinguishing features, ontogenetic changes, maximum size, distribution, and number and shape of teeth. Determination of the first dorsal fin origin in relation to the pectoral fin is important for identifying most species of *Carcharhinus*. If it is difficult to make this determination, when feasible use some type of straight edge or string held vertical to landed specimens beginning at the first dorsal fin origin extending in a straight line down to the pectoral fin. It is helpful to orient specimens too large to land dorso-ventrally to assess the dorsal fin origin from an overhead or side view.

When specimens are landed, morphometric characteristics in the species descriptions (i.e., snout length compared to mouth width) will be helpful for separating species. For specimens too large to land, morphometric characteristics will be of limited value depending on the specimen's condition (highly active or passive). If morphometric measurements are possible, verification with Garrick (1982, 1985) is recommended for *Carcharhinus* species, and Compagno (1984) is recommended for *Rhizoprionodon* species; distinguishing other carcharhinids does not require morphometric measurements. The second dorsal fin origin in relation to the anal fin base is an important feature, especially for distinguishing the smaller-sized carcharhinids, *Rhizoprionodon* species, smalltail sharks, blacknose sharks, and finetooth sharks, all with maximum sizes less than 164.0 cm TL. Most small sharks can be landed and determining the position of the second dorsal fin is not difficult.

Discussion

To facilitate identifications, every effort has been made to utilize unique external features, however, some species closely resemble each other and several external features must be used for accurate identifications. Sharks with an interdorsal ridge and the dorsal fin origin over the pectoral fin inner margin are most difficult to identify. This group includes the sandbar shark *(Carcharhinus plumbeus,* it is uncommon for dorsal fin origin to be over the pectoral fin inner margin), bignose shark (*Carcharhinus altimus*), night shark (*Carcharhinus signatus),* Galapagos sharks, dusky shark (*Carcharhinus obscurus*), and reef shark (*Carcharhinus perezi*); these six species share features used on the separation sheet for carcharhinids with an interdorsal ridge (Fig. 4). They are grouped separately from other species through the process of elimination but ultimately are distinguished from each other by characteristics that can include the snout, pectoral fin, teeth, habitat, and distribution. Careful attention to detail should be exercised when separating similar species (species grouped together on the species separation sheets); there is no reliable method for identifications if key characteristics are not confirmed. It is recommended that species descriptions for similar species be reviewed before establishing an identification.

When time permits and release of specimens with a minimum of stress is not a concern, detailed taxonomic references offering full descriptions should be used to verify identifications. Taxonomic references often utilize proportional measurements and meristics (vertebral counts and dental formulas) to separate species, and generally provide detailed species descriptions and illustrations of important characteristics. Bigelow and Schroeder (1948) state adults of *Carcharhinus,* "resemble one another so closely in general appearance that little or no dependence can be placed on published reports of occurrence unless accompanied by some indication as to fins, teeth, etc., . . . they are separable by characters so precise and so little variable that specific identification is not difficult, although attention to detail is required."

Identifications can be difficult for specimens not captured or landed, however, species identification under these circumstances can be accomplished using combinations of characteristics, including not only external features but also locality and behavior.

Key to Carcharhinidae

1a First dorsal fin base midpoint closer to pectoral fin axil than pelvic fin origin, or at most midway between **2**

1b First dorsal fin base midpoint closer to pelvic fin origin than pectoral fin axil. Pectoral fins long and tapered. Dark blue dorsally, brilliant blue sides, white ventrally (Fig. 5) ..... **blue shark, *Prionace glauca***

2a No caudal keels **3**

2b Caudal keels present. Snout bluntly rounded and short. Small spiracles posterior to eyes. Upper caudal fin lobe elongate with pointed apex. Body can be noticeably mottled or with vertical stripes (Fig. 6) ..... **tiger shark, *Galeocerdo cuvier***

3a Second dorsal fin much smaller than first dorsal fin **4**

3b Second dorsal fin almost as large as first dorsal fin. Pectoral fins broad and not elongate; pelvic and anal fins about equal size (Fig. 7) ..... **lemon shark, *Negaprion brevirostris***

4a Second dorsal fin origin over or posterior to anal fin base midpoint **5**

4b Second dorsal fin origin anterior to anal fin base midpoint **6**

5a Labial furrows well developed and visible in profile view. Teeth smooth or weakly serrated (Figs. 8, 9, and 10) ..... **sharpnose sharks, *Rhizoprionodon***

5b Labial furrows not well developed and generally not visible in profile view. Teeth with distinct serrations (Fig. 11) ..... **smalltail shark, *Carcharhinus porosus***

6a Snout elongate and flattened in profile, appears triangular from overhead view (Fig. 12) ..... **daggernose shark, *Isogomphodon oxyrhynchus***

6b Snout not elongate and flattened in profile, does not appear triangular from overhead view **7**

7a First dorsal fin apex and pectoral fin apex broadly rounded, most fins with white tips (Fig. 13) ..... **oceanic whitetip shark, *Carcharhinus longimanus***

7b First dorsal fin apex and pectoral fin apex angular or sharply rounded; not broadly rounded with white tips **8**

8a Interdorsal ridge present (Fig. 4)

8b No interdorsal ridge (Fig. 3)

Species accounts

Blue shark, *Prionace glauca* (Fig. 5)

No interdorsal ridge. First dorsal fin base midpoint closer to pelvic fin origin than pectoral fin axil. Pectoral fins long and moderately falcate. Snout sharply rounded and long; snout length greater than mouth width. Keels on each side of caudal peduncle. Upper teeth serrated and with concave margin. Dental formula: 14–0 or 1–14/ 13 to 15–1 to 4–13 to 15 (Bigelow and Schroeder, 1948); tooth redrawn from Compagno (1984). Body blue dorsally, brilliant blue along sides and white below (coloration fades after death). Maximum size; 341.5 cm TL (Pratt, 1979). Range: from the Banks of Newfoundland, Canada (during summer) south, including the Gulf of Maine, Bermuda, the Bahamas, Gulf of Mexico, Caribbean, and the north coast of South America (Bigelow and Schroeder, 1948; Compagno, 1984). Habitat: typically beyond the continental shelf but occasionally found inshore.

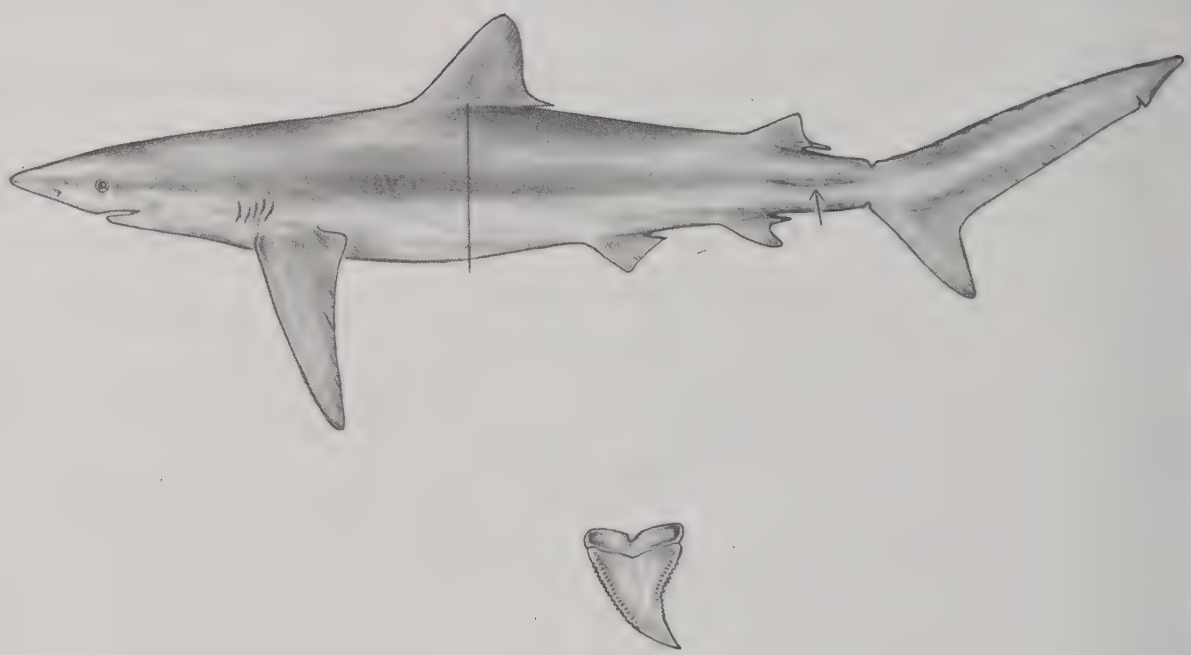


Figure 5
Blue shark, *Prionace glauca*.

Tiger shark, *Galeocerdo cuvier* (Fig. 6)

Interdorsal ridge present. First dorsal fin origin over pectoral fin inner corner. Snout broadly rounded; length less than mouth width. Upper labial furrows long and terminate underneath eyes (McEachran and Fechhelm, 1998). Caudal keels on each side of caudal peduncle. Small spiracles posterior to eyes. Upper lobe of caudal fin elongate with pointed apex. Upper and lower teeth broad and serrated with hooked cusps. Dental formula: 9 to 11–1–9 to 12/ 9 to 12–1–9 to 12 (Bigelow and Schroeder, 1948); tooth redrawn from Compagno (1984). Body gray or gray brown above and yellowish or white below. Dark gray or brown spots form blotches and irregular vertical or oblique bars along body, dorsal fins, and upper caudal fin lobe; markings more distinct in young and faded or absent in adults. Neonates and juveniles can have white-tipped first dorsal fin. Maximum size: 550.0 cm TL (Bigelow and Schroeder, 1948); 410.0 cm TL (Branstetter, 1981); 287.0 cm TL (fork length converted to TL with conversion from Kohler et al., 1996) and 416.8 cm TL estimated (NMFS, n = 154). Range: from Massachusetts south, including Bermuda, the Bahamas, Gulf of Mexico, and Caribbean (Bigelow and Schroeder, 1948). Habitat: coastal to outer continental shelf; estuaries, bays, coral atolls, island passes, and depths to 140 m, occasionally oceanic (Compagno, 1984).

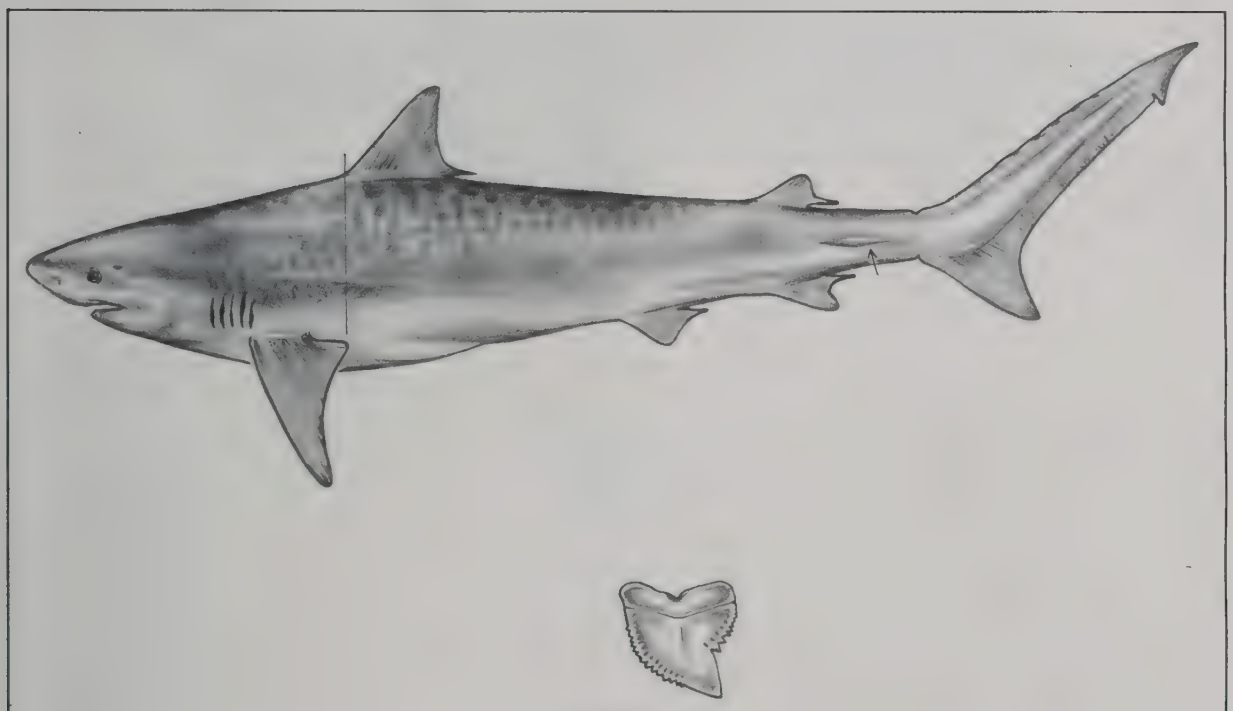


Figure 6
Tiger shark, *Galeocerdo cuvier*.

Lemon shark, *Negaprion brevirostris* (Fig. 7)

No interdorsal ridge. First dorsal fin origin over or posterior to pectoral fin inner corner. Second dorsal fin almost as large as first dorsal fin; anal fin almost as large as pelvic fins. Snout bluntly rounded; snout length less than mouth width. Compagno (1988) reported two specimens with very small spiracles .08 of eye length, but spiracles are usually absent. Upper teeth with narrow smooth cusps and basal serrations. Dental formula: 15–1 to 3–15/ 13 or 14–3–13 or 14 (Bigelow and Schroeder, 1948); tooth redrawn from Compagno (1984). Body gray blue, brown or brownish yellow above and yellowish or white below. Maximum size: is 368.0 cm TL (Gruber and Stout, 1983); 200.0 cm TL estimated (NMFS, $n = 2$). Range: from New Jersey south, including the Bahamas, Gulf of Mexico, and Caribbean. Habitat: river mouths, estuaries, saline creeks, bays, sounds, coral keys; coastal to 92 m depth and occasionally in open ocean (Compagno, 1984).

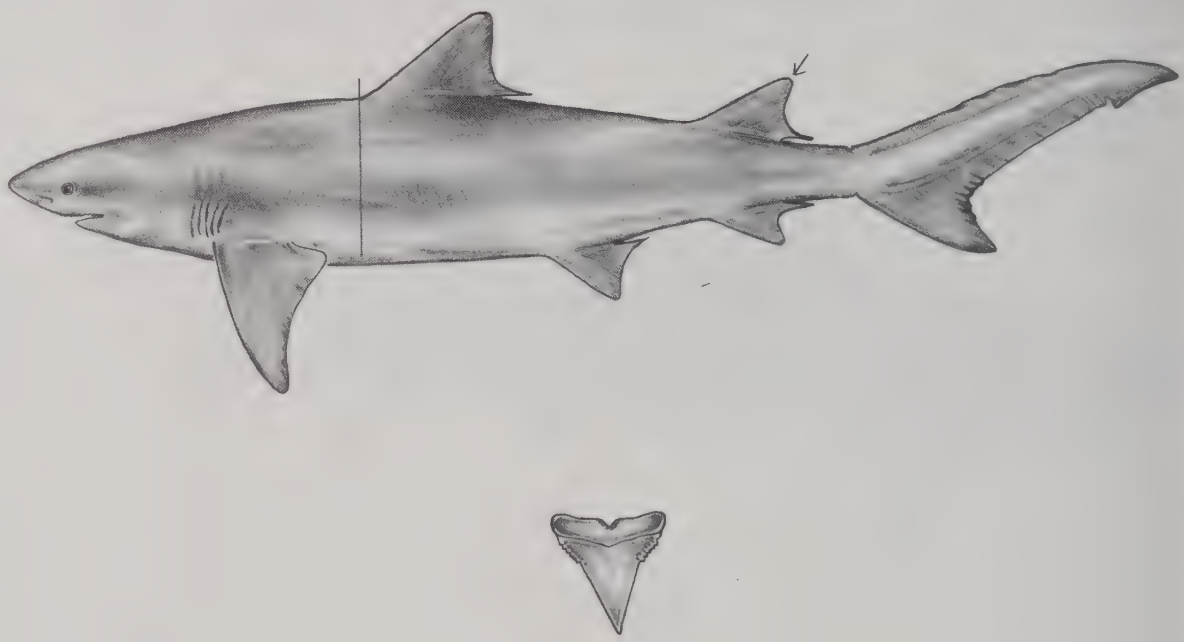


Figure 7
Lemon shark, *Negaprion brevirostris*.

Brazilian sharpnose shark, *Rhizoprionodon lalandii* (Fig. 8)

Interdorsal ridge weakly developed or absent. First dorsal fin origin over or slightly posterior to pectoral fin inner corner. Second dorsal fin origin from over anal fin base midpoint to anal fin base termination. Snout moderately rounded. Pectoral fins short and broad. Well-developed labial furrows. Upper teeth with smooth oblique cusps, sometimes with very fine irregular serrations. Dental formula: 12–1–12/11 to 12–12 to 12 (Springer, 1964); tooth redrawn from Springer (1964). Precaudal vertebral centra 79–90, total vertebral centra 153–168 (Compagno, 1984). Body dark gray or gray brown above and light gray below. Maximum size: 77.0 cm TL (Compagno, 1984). Range: from the Caribbean coast of Panama extending along the north coast of South America. Habitat: mud and sand bottoms, estuaries and lagoons; coastal in 3 to 70 m depth (Compagno, 1984). The range for the Brazilian sharpnose shark overlaps with the Caribbean sharpnose shark. Distinguished from the Caribbean sharpnose shark by the number of precaudal and total vertebral centra (Caribbean sharpnose sharks with 66 to 75 precaudal vertebral centra and 136 to 159 total vertebral centra). Distinguished from the smalltail shark by possessing well-developed labial furrows and teeth with oblique cusps. Species account and illustration adapted from Meek and Hildebrand, 1923; Springer, 1964; Uyeno and Sasaki, 1983; Compagno, 1984.

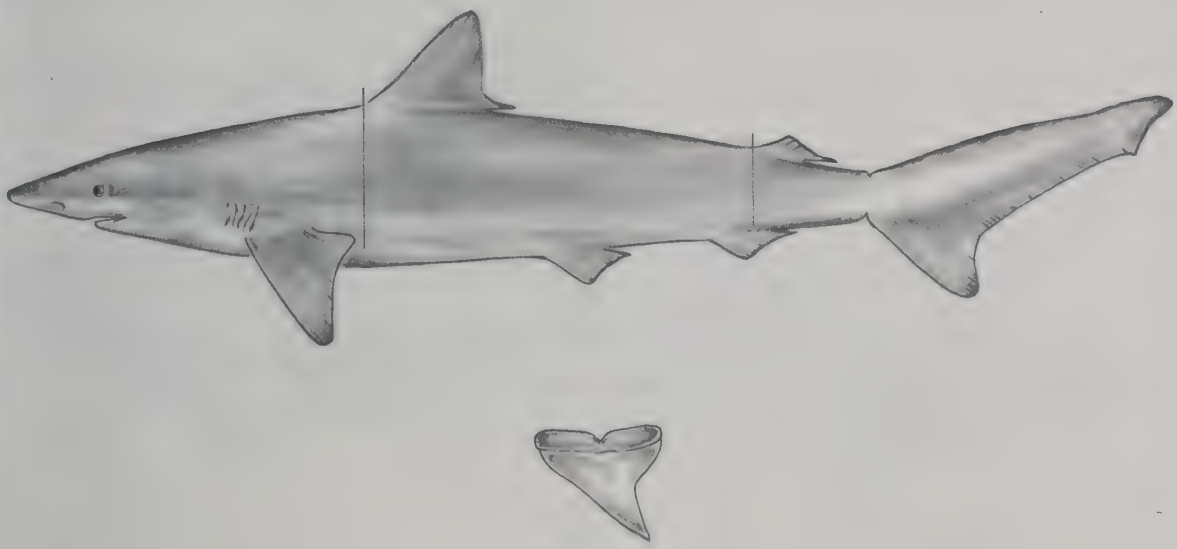


Figure 8
Brazilian sharpnose shark, *Rhizoprionodon lalandii*.

Caribbean sharpnose shark, *Rhizoprionodon porosus* (Fig. 9)

Interdorsal ridge weakly developed or absent. First dorsal fin origin over or slightly posterior to pectoral fin inner corner. Second dorsal fin origin from over anal fin base midpoint to anal fin base termination. Snout moderately rounded. Well-developed labial furrows. Upper teeth with finely serrated oblique cusps. Body gray brown or brown above and white below; body sometimes with white spots (Compagno, 1984) and white fin margins along the rear edge of the first dorsal fin and pectoral fins (Guitart, 1974). Dental formula: 11 to 13–1–11 to 13/ 12–12 (Springer, 1964); tooth redrawn from Springer (1964). Precaudal vertebral centra 66–75, total vertebral centra 136–159 (Compagno, 1984). Maximum size: 110.0 cm TL (Compagno, 1984). Range: from the Bahamas south including the north coast of Cuba in the Gulf of Mexico, throughout the Caribbean, and along the north coast of South America. Habitat: coastal to 500 m depth (Compagno, 1984). Range overlaps with the Atlantic sharpnose shark in the Bahamas and along the north coast of Cuba (though the distribution of the Atlantic sharpnose shark in Cuba is questionable, Guitart-Manday[12]); range overlaps with the Brazilian sharpnose shark (*Rhizoprionodon lalandii*) from the Caribbean coast of Panama extending along the north coast of South America. Distinguished from the Atlantic sharpnose and the Brazilian sharpnose by the number of precaudal and total vertebral centra (Brazilian sharpnose shark with 79 to 90 precaudal vertebral centra and 153 to 168 total vertebral centra; Atlantic sharpnose shark with 58 to 66 precaudal vertebral centra and 126 to 144 total vertebral centra; Compagno, 1984). Distinguished from the smalltail shark by possessing well-developed labial furrows and weakly serrated teeth with slightly oblique cusps. Species account and illustration adapted from Springer, 1964; Guitart, 1974; Uyeno and Sasaki, 1983; Compagno, 1984.

[12] Guitart-Manday, D. 1998. Centro de Investigaciones de Marinos, Universidad de Habana, Habana, Cuba. Personal commun.

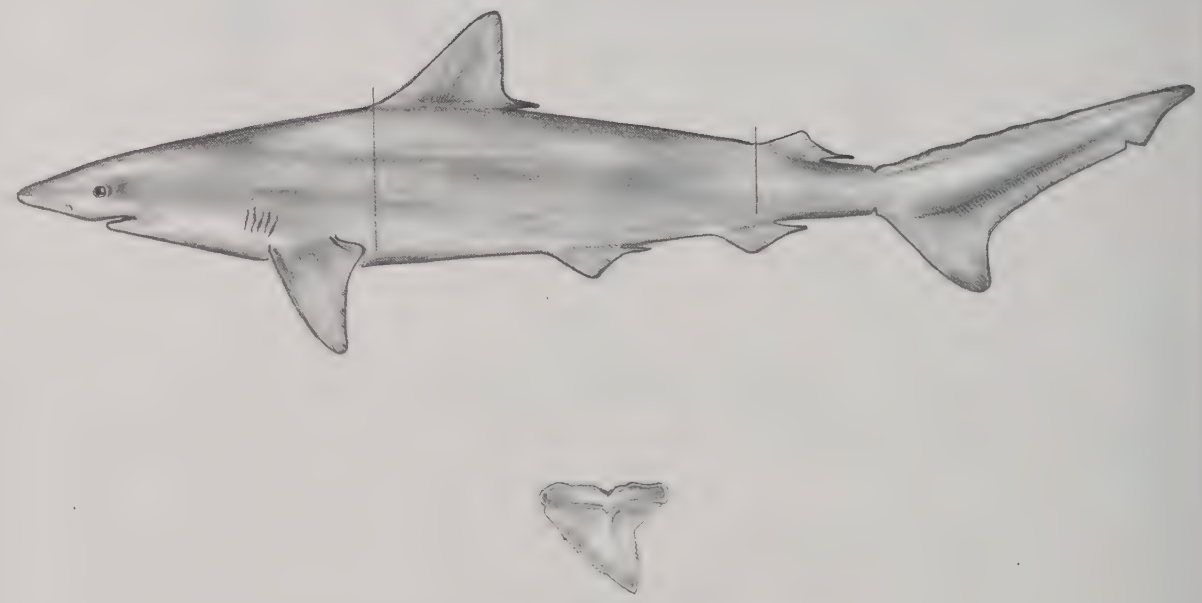


Figure 9

Caribbean sharpnose shark, *Rhizoprionodon porosus*.

Atlantic sharpnose shark, *Rhizoprionodon terraenovae* (Fig. 10)

Interdorsal ridge usually present; but can be weakly developed or absent (Compagno, 1984). First dorsal fin origin slightly anterior to over pectoral fin inner corner. Second dorsal fin origin from over or anal fin base midpoint to anal fin base termination. Snout moderately or sharply rounded. Well-developed labial furrows. Upper teeth finely serrated with hooked cusps. Body gray or gray brown above and pale gray or white below; frequently with pale or white spots. Pectoral fins often with white rear margins. First and second dorsal fins can have dusky tips. Dental formula: 11 to 13–1–12 to 13/12 to 13–12 to 13 (Springer, 1964); tooth redrawn from Compagno (1984). Precaudal vertebral centra 58–66, total vertebral centra 126–144 (Compagno, 1984). Maximum size: 110.0 cm TL (Branstetter, 1981); 107.0 cm TL (Parsons, 1985); 120.0 cm TL (NMFS, n = 1719). Range: from New Brunswick, Canada south to the north-central coast of Cuba (the distribution of the Atlantic sharpnose shark in Cuba is questionable, Guitart-Manday[12]), including parts of the Bahamas, and the entire Gulf of Mexico. Habitat: river mouths, estuaries, bays, sounds; coastal to 280 m depth (Compagno, 1984). Range overlaps with the Caribbean sharpnose shark in the Bahamas and along the north coast of Cuba. Distinguished from the Caribbean sharpnose shark by possessing teeth with hooked cusps and by the number of precaudal and total vertebral centra (Caribbean sharpnose shark with 66 to 75 precaudal vertebral centra and 136 to 159 total vertebral centra; Compagno, 1984). Distinguished from the smalltail shark by possessing smooth or weakly serrated teeth with hooked cusps and well-developed labial furrows.

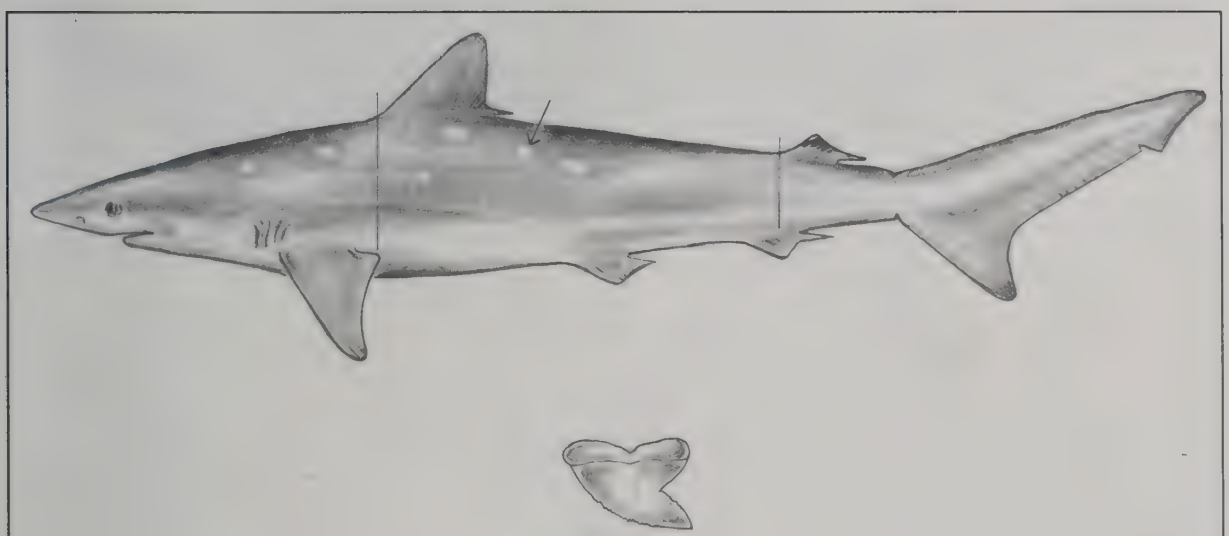


Figure 10
Atlantic sharpnose shark, *Rhizoprionodon terraenovae*.

Smalltail shark, *Carcharhinus porosus* (Fig. 11)

No interdorsal ridge. First dorsal fin origin over pectoral fin inner margin. Second dorsal fin origin from over anal fin base midpoint to anal fin base termination. Snout sharply rounded; snout length greater than mouth width. Caudal fin length approximately 1/4 of the TL. Labial furrows weakly developed, usually not visible in profile. Pectoral fins short and broad. Upper teeth broad and serrated and with a distinct notch along margin. Dental formula: 13 to 15–1 or 2–13 to 15/ 12 to 15–0 to 2–12 to 15 (Garrick, 1982). Body gray or gray blue above and white below. Maximum size: 150.0 cm TL (Compagno, 1984); 106.7 cm TL (NMFS, $n = 1$). Range: north central and western Gulf of Mexico and western and southern Caribbean. Habitat: coastal to 36 m depth and mud bottoms in proximity of large rivers and estuaries (Springer, 1950; Compagno, 1984). Smalltail sharks can be confused with *Rhizoprionodon* species, however, smalltail sharks have weakly developed labial furrows and serrated teeth; *Rhizoprionodon* species have well developed labial furrows and smooth or weakly serrated teeth (teeth with oblique cusps for Brazilian sharpnose sharks and Atlantic sharpnose sharks). The second dorsal fin origin over or posterior to the anal fin base midpoint for smalltail sharks distinguishes smalltail sharks from finetooth sharks (*Carcharhinus isodon*).

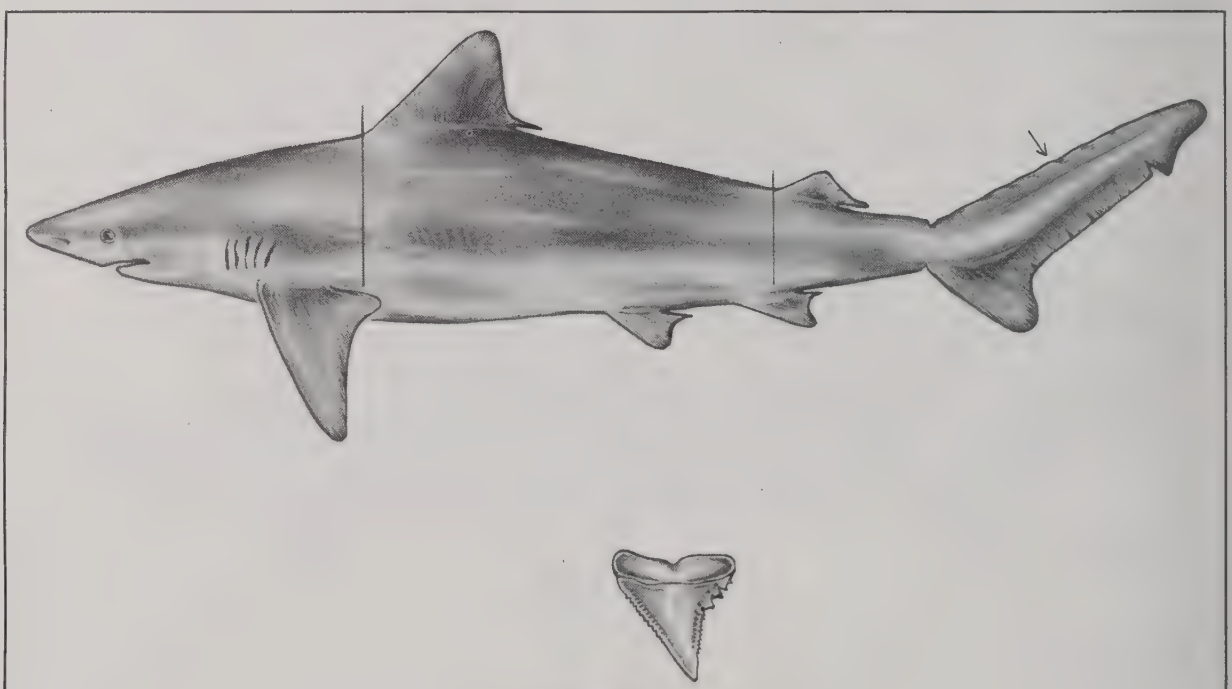


Figure 11
Smalltail shark, *Carcharhinus porosus.*

Daggernose shark, *Isogomphodon oxyrhynchus* (Fig. 12)

No interdorsal ridge. First dorsal fin origin anterior to pectoral fin axil. Snout appears elongate and flattened in profile and sharply triangular from overhead view. Broad pectoral fins. Uyeno and Sasaki (1983) reported a small spiracle on the left side of the head, but whether this is a consistent feature for all daggernose sharks is not certain since only one specimen was examined and other references do not mention the presence of spiracles. Upper and lower teeth narrow and erect and finely serrated. Dental formula: 23–4–22/24–2–23 (Bigelow and Schroeder, 1948); tooth redrawn from Compagno (1984 and 1988). Body gray or gray brown above and white below. Maximum size: 152.0 cm TL (Compagno, 1984); 145.0 cm TL (Lessa et al., 1999). Range: reported from Trinidad in the southern Caribbean and along the north coast of South America to French Guiana; also reported from eastern Brazil, Valence, Bahia (Compagno, 1984). Habitat: coastal, estuaries, river mouths, and rocky bottoms; strong association with mud bottoms (Lessa et al., 1999). Species account and illustration adapted from Bigelow and Schroeder, 1948; Uyeno and Sasaki, 1983; Compagno, 1984; Lessa et al., 1999.

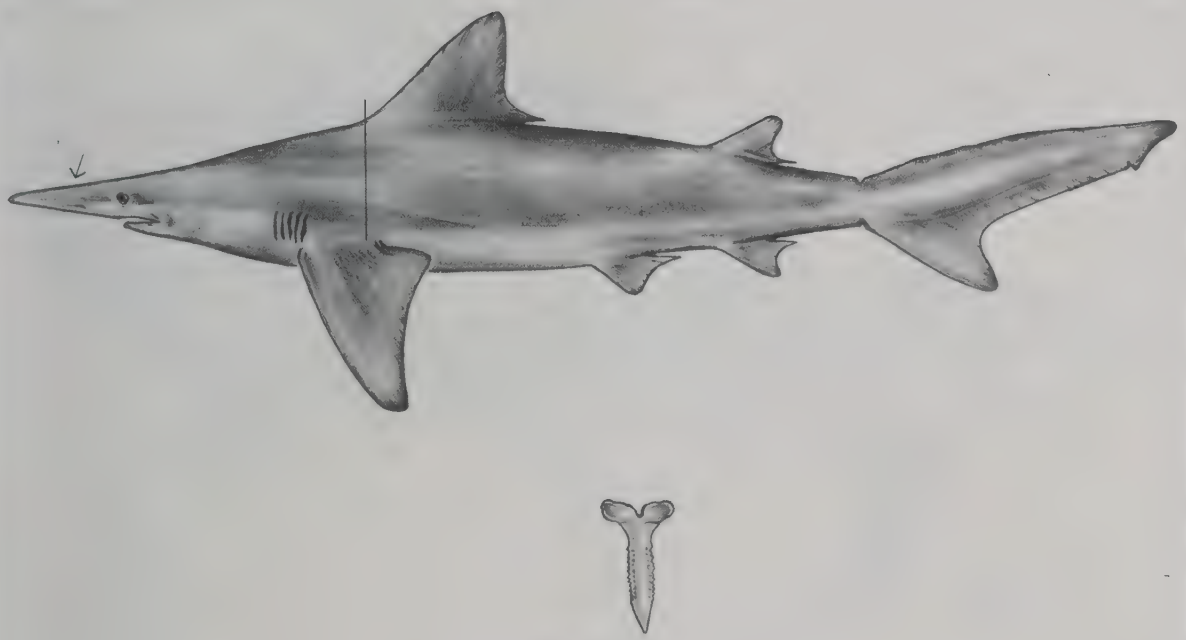


Figure 12

Daggernose shark, *Isogomphodon oxyrhynchus*.

Oceanic whitetip shark, *Carcharhinus longimanus* (Fig 13)

Interdorsal ridge generally present; sometimes difficult to discern or absent (Garrick, 1982). First dorsal fin origin over pectoral fin inner margin; sometimes first dorsal fin origin is posterior to pectoral fin inner corner (Ritter[13]). Dorsal fin high and apex broadly rounded. Pectoral fins long and broad with broadly rounded apex. Snout bluntly rounded; length less than or equal to mouth width. Upper teeth broad and serrated; lower teeth moderately narrow with fine serrations. Dental formula: 14 or 15–1 or 2–14 or 15/ 13 to 15–1–13 to 15 (Bigelow and Schroeder, 1948; Garrick, 1982). Body gray or gray brown above and yellowish or white below. Tips of the dorsal fin, pectoral fins, and upper lobe of caudal fin are usually white; sometimes fin tips are gray (Bigelow and Schroeder, 1948) or not pigmented (Castro, 1983). Embryos (Bigelow and Schroeder, 1948) and young (Garrick, 1982) can have gray or black tips on first and second dorsal fin, pelvic fins, and lower caudal fin lobe; the caudal peduncle area can be pigmented dark or dusky (Guitart-Manday[12]). Maximum size; 350.0 cm TL (Bigelow and Schroeder, 1948); 246.0 cm TL (Backus et al., 1956). Range: from Maine south, including the Gulf of Mexico, Caribbean, and the north coast of South America. Habitat: oceanic, usually beyond the continental shelf; can occur inshore by oceanic islands or in areas with a narrow continental shelf (Compagno, 1984).

[13] Ritter, E. 1997. Green Marine, 11517 S.W. 64th St. #A, Miami, FL 11549. Personal commun.

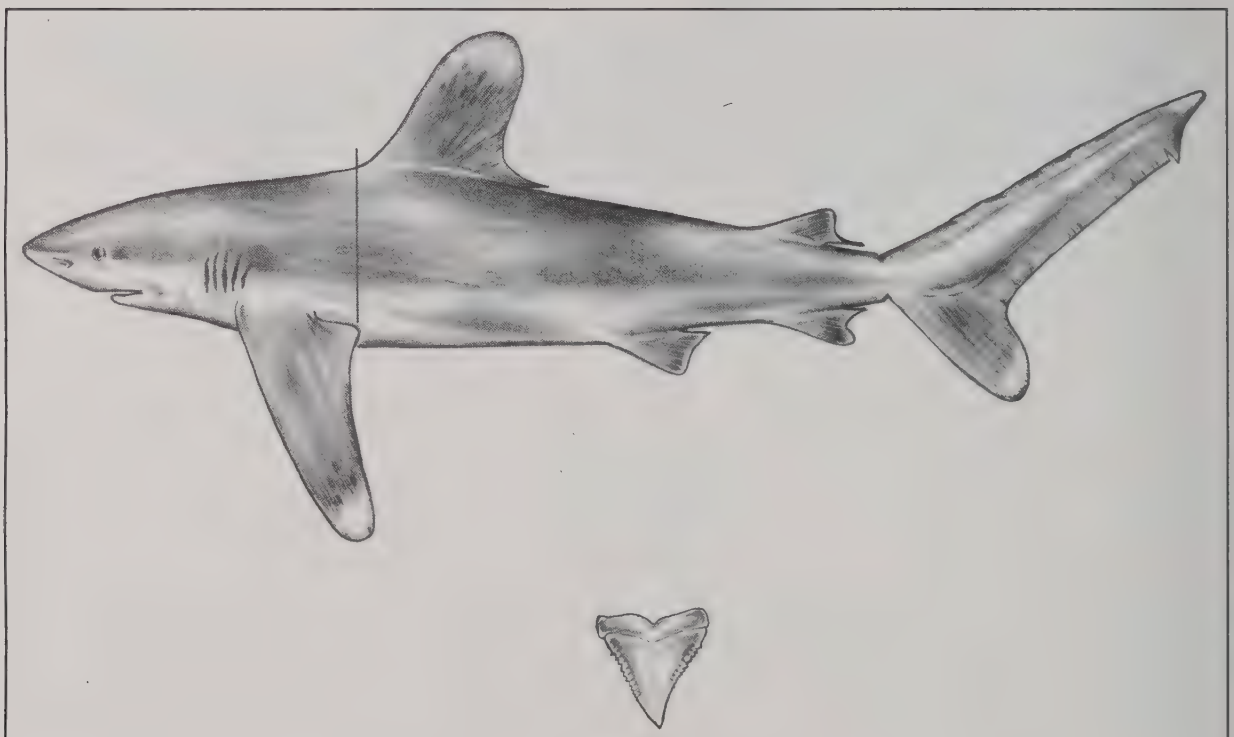


Figure 13
Oceanic whitetip shark, *Carcharhinus longimanus.*

Bull shark, *Carcharhinus leucas* (Fig. 14)

No interdorsal ridge. First dorsal fin origin anterior to pectoral fin axil; sometimes first dorsal fin origin is over pectoral fin axil (Garrick, 1982; Compagno, 1984). First dorsal fin high and triangular. Pectoral fins moderately long and broad. Snout bluntly rounded and short; snout length less than mouth width. Body generally robust for larger specimens, especially for those greater than 150.0 cm TL. Upper teeth broad and serrated. Dental formula: 12 to 14–1–12 to 14/ 12 or 13–2–12 or 13 (Garrick, 1982). Body dark gray or gray above and white below. Maximum size: 274.0 cm TL (Springer, 1950); 268.0 cm TL (Branstetter and Stiles, 1987); 260.0 cm TL and 298.7 cm TL estimated (NMFS, n = 20). Range: from New York south including the Bahamas, Gulf of Mexico, and Caribbean. Habitat: coastal, but can occur in brackish or fresh water rivers and lakes that connect with marine habitats. Distinguished from sandbar sharks by lack of an interdorsal ridge.

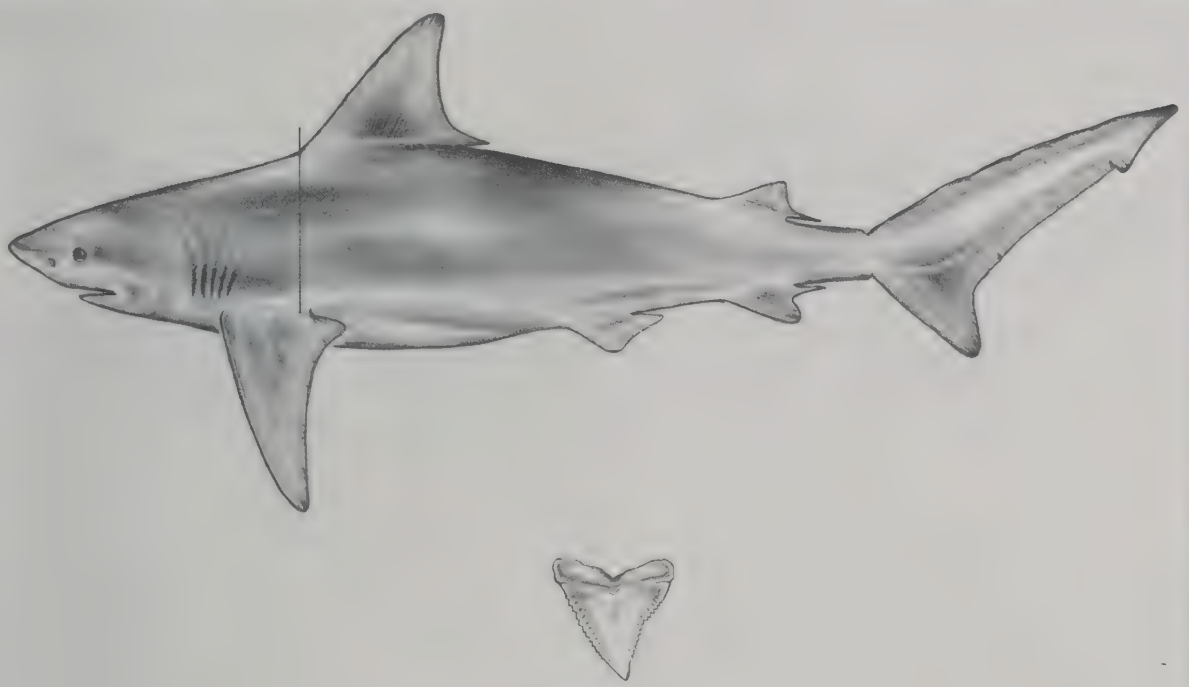


Figure 14
Bull shark, *Carcharhinus leucas*.

Blacknose shark, *Carcharhinus acronotus* (Fig. 15)

No interdorsal ridge. First dorsal fin origin over pectoral fin inner margin; sometimes first dorsal fin origin is posterior to pectoral fin inner corner (Bigelow and Schroeder, 1948; Castro, 1983). Snout moderately or sharply rounded; snout length generally equal to or greater than mouth width; Garrick (1982) reports a specimen with snout length less than mouth width. Pectoral fins short, often with white rear margin. Upper teeth moderately narrow and serrated (serrations often difficult to discern for juveniles, Cortes[10]) with oblique cusps and with distinct notch along margin. Dental formula: 12 or 13–1 or 2–12 or 13/11 or 12–1–11 or 12 (Garrick, 1982). Snout tip with dark (juveniles) or dusky blotch (adults). Body gray or gray olive above and yellowish or white ventrally. Maximum size: 164.0 cm TL (Schwartz, 1984); 130.0 cm TL (NMFS, n = 229). Range: from North Carolina south, including the Bahamas, Gulf of Mexico, and Caribbean. Habitat: coastal, often close to shore.

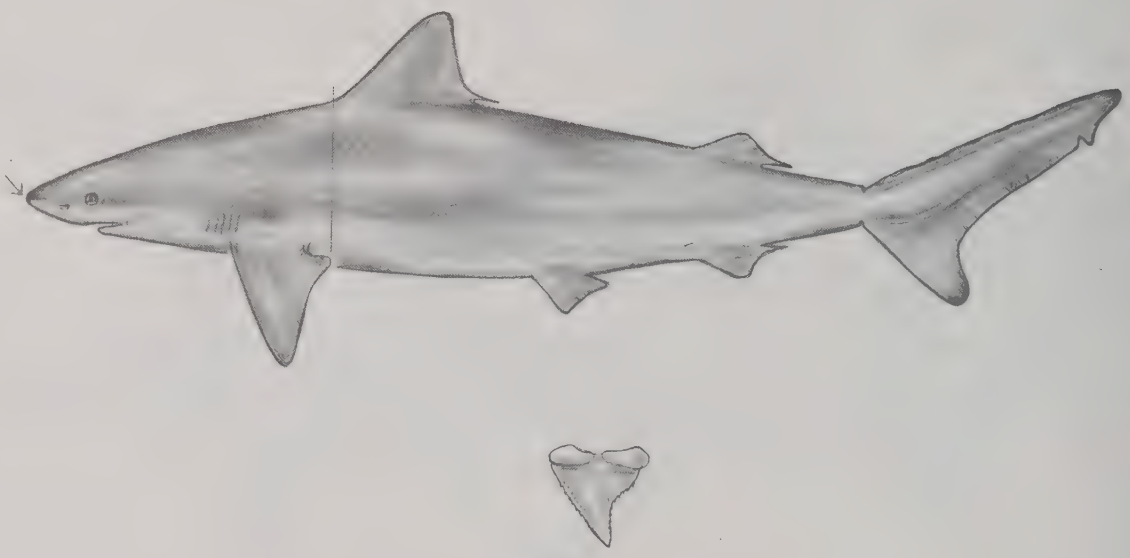


Figure 15
Blacknose shark, *Carcharhinus acronotus*.

Finetooth shark, *Carcharhinus isodon* (Fig. 16)

No interdorsal ridge. First dorsal fin origin over pectoral fin inner margin. Snout moderately rounded; length less than mouth width. Upper and lower teeth narrow and weakly serrated, almost smooth. Pectoral fins short and broad. Baughman and Springer (1950) considered the long gill slits (twice the length of the eye diameter) to be an important distinguishing feature. Dental formula: 13 to 15–1–13 to 15/ 13 to 15–1 to 3–13 to 15 (Castro, 1983). Tooth redrawn from Garrick (1985). Body color is gray or gray blue above and white below, can have a dusky band extending posteriorly from pectoral fin; some specimens can have green eyes but this may be a localized trait for specimens from the Florida panhandle (Carlson[14]). Maximum size: 160.0 cm TL (Castro, 1993); 148.0 cm TL (NMFS, n = 35). Range: from New York south to Cuba, including parts of the Bahamas and the Gulf of Mexico; in the Caribbean along the south coast of Cuba. Habitat: coastal in depths as shallow as 4 m (Castro, 1983). Distinguished from the smalltail shark by the second dorsal fin origin; second dorsal fin origin for the finetooth shark is anterior to the anal fin base midpoint; for the smalltail shark the second dorsal fin origin is over or posterior to the anal fin base midpoint.

[14] Carlson, J. 2000. NMFS Panama City Laboratory, 3500 Delwood Beach Rd., Panama City, FL 32408. Personal commun.

Figure 16
Finetooth shark, *Carcharhinus isodon*.

Blacktip shark, *Carcharhinus limbatus* (Fig. 17)

No interdorsal ridge. First dorsal fin origin over pectoral fin inner margin. Snout moderately or sharply rounded; snout length less than or equal to mouth width. Upper and lower teeth narrow, erect and finely serrated. Dental formula: 14 or 15–1 to 3–14 or 15/ 13 to 15–1 or 2–13 to 15 (Bigelow and Schroeder, 1948). Body dark gray, gray blue or gray brown above and white below. A dark chevron-shaped band originates near the pectoral fin and extends posteriorly. First dorsal fin, second dorsal fin, pectoral fins, pelvic fins, and lower lobe of caudal fin generally with distinct black tips; sometimes black tips are faded or nearly obsolete for larger specimens, especially on outer surfaces of paired fins. Some specimens have circular parasite scars located between the first and second dorsal fin. For specimens greater than 80 cm TL, the anal fin is pale or white (Branstetter, 1982). Maximum size: 202.0 cm TL (Castro, 1993); 188.0 cm TL and 200.0 cm TL estimated (NMFS, n = 207). Range: from Massachusetts south, including the Bahamas, Gulf of Mexico, and Caribbean (Garrick, 1982). Habitat: coastal and occasionally offshore; inshore from river mouths, shallow bays, estuaries, island lagoons, and coral reef drop offs (Compagno, 1984). In the western North Atlantic, the pale or white anal fin distinguishes blacktip sharks greater than 80.0 cm TL from spinner sharks, however, it may be difficult to separate specimens of each species when their length is less than 80.0 cm TL (Branstetter, 1982). In profile, blacktip sharks generally appear more robust between the snout and first dorsal fin than spinner sharks. The first dorsal fin origin is another distinguishing feature that can be useful for separating blacktip sharks from spinner sharks; for blacktip sharks the first dorsal fin origin is generally over the pectoral fin inner margin, for spinner sharks the first dorsal fin origin is generally posterior to the pectoral fin inner corner. Branstetter (1982) states a useful morphometric feature for separating blacktip and spinner sharks is the comparison of the prenare length to the postnare length; for blacktip sharks the prenare length is less than or equal to the postnare length; for spinner sharks the prenare length is greater than the postnare length.

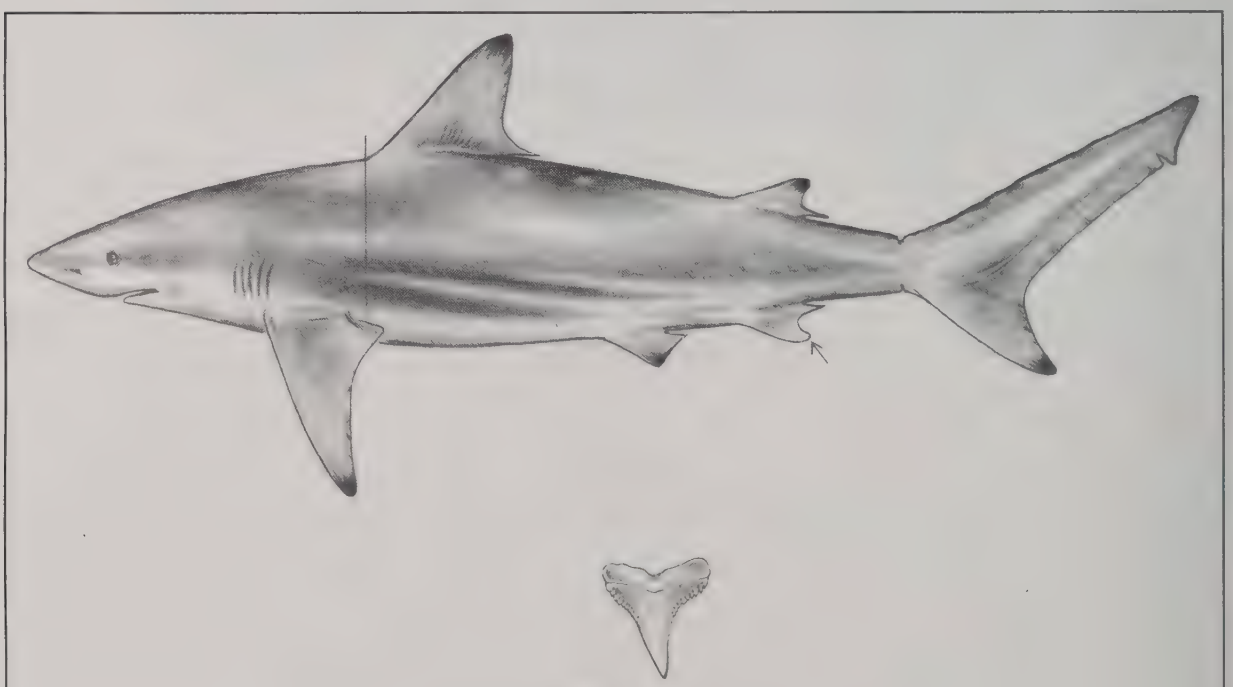


Figure 17

Blacktip shark, *Carcharhinus limbatus*.

Spinner shark, *Carcharhinus brevipinna* (Fig. 18)

No interdorsal ridge. First dorsal fin origin posterior to pectoral fin inner corner; sometimes first dorsal fin origin is over pectoral fin inner margin (Castro, 1983). Snout long and sharply rounded, snout length equal to or greater than mouth width. Upper teeth narrow and finely serrated, lower teeth smooth. Dental formula: 16–2 or 3–16/ 15–1 or 3–15 (Garrick, 1982). Body gray or gray blue above and white below; often with a dark chevron-shaped band originating near the pectoral fin and extending posteriorly. Some specimens have circular parasite scars located between the first and second dorsal fin. Young under 80.0 cm TL have unmarked fins (Branstetter, 1982) or narrow-dark fin margins (Garrick, 1982). Adults with first dorsal, second dorsal, pectoral, anal, and lower lobe of caudal fin black tipped; pelvic fins can be black tipped (Garrick, 1982). Sometimes black tips are faded or nearly obsolete for larger specimens, especially on outer surfaces of paired fins. Maximum size: 244.0 cm TL (Springer, 1960); 208.0 cm TL (Branstetter, 1987a); 194.0 cm TL (NMFS, $n = 87$). Range: from North Carolina south to the north coast of Cuba, including the Bahamas and Gulf of Mexico. Habitat: coastal to 75 m depth (Compagno, 1984). In the western North Atlantic, the black tipped anal fin distinguishes spinner sharks greater than 80.0 cm TL from blacktip sharks, however, it may be difficult to separate specimens of each species when their length is less than 80.0 cm TL (Branstetter, 1982). In profile, spinner sharks generally appear more slender between the snout and first dorsal fin than blacktip sharks. The first dorsal fin origin is another distinguishing character that can be useful for separating spinner sharks from blacktip sharks; for spinner sharks the first dorsal fin origin is generally posterior to the pectoral fin inner corner, for blacktip sharks the first dorsal fin origin is over the pectoral fin inner margin. Branstetter (1982) states a useful morphometric feature for separating spinner and blacktip sharks is the comparison of the prenare length to the postnare length; for spinner sharks the prenare length is greater than the postnare length; for blacktip sharks the prenare length is less than or equal to the postnare length.

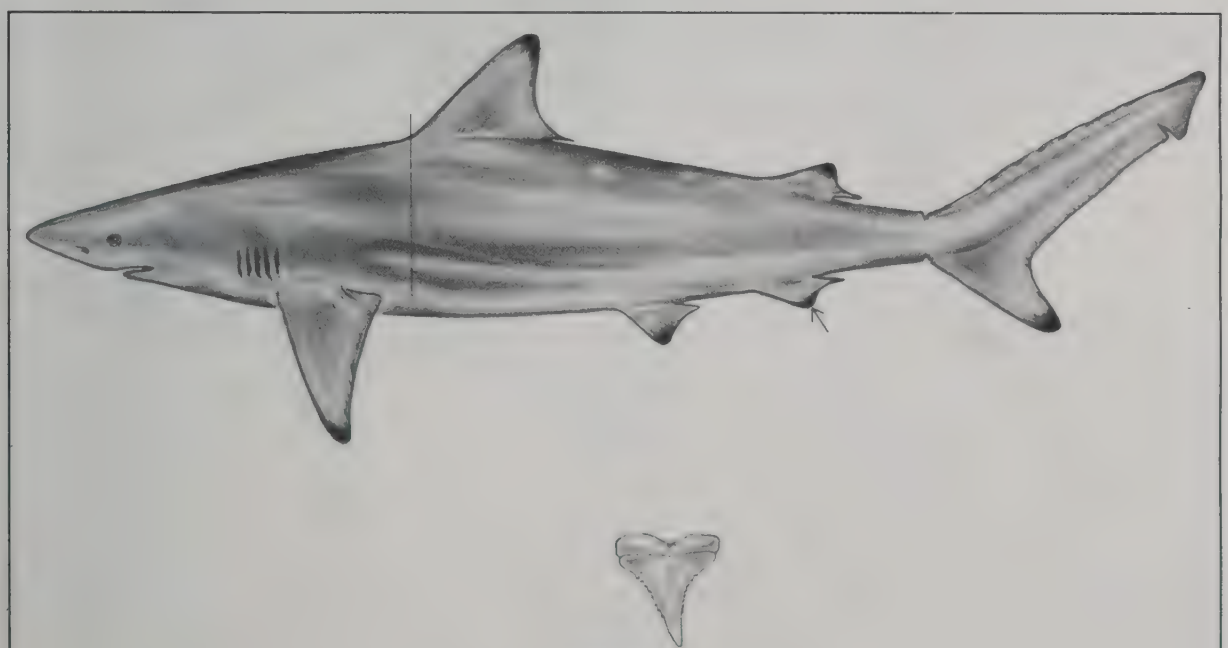


Figure 18
Spinner shark, *Carcharhinus brevipinna*.

Sandbar shark, *Carcharhinus plumbeus* (Fig. 19)

Interdorsal ridge present. First dorsal fin origin slightly anterior to or over pectoral fin axil; Garman (1997) reports the first dorsal fin origin slightly posterior to pectoral fin axil to the midpoint of the pectoral fin inner margin. Dorsal fin high and triangular; dorsal fin height in adults sometimes more than twice snout length (Castro, 1983). Pectoral fins long and broad. Snout bluntly rounded, snout length less than mouth width. Upper teeth broad and serrated. Dental formula: 14 to 16–2–14 to 16/ 12 to 15–1–12 to 15 (Bigelow and Schroeder, 1948). Body gray, gray blue or gray brown above and white below. Maximum size: 243.0 cm TL (Springer, 1960); 222.0 cm TL and 243.7 cm TL estimated (NMFS, n = 127). Range: from Massachusetts south, including the Bahamas, Gulf of Mexico, and most of the Caribbean. Habitat: shallow coastal waters, bays, harbors, and estuaries; occasionally to 315 m depth (Castro, 1983). Sandbar sharks are distinguished from bull sharks by the presence of an interdorsal ridge. Even though the dorsal fin origin for sandbar sharks is generally anterior to the pectoral fin axil, if the dorsal fin origin is over the pectoral fin inner margin, sandbar sharks are grouped with several other similar species (bignose shark, night shark, Galapagos shark, dusky shark, and reef shark). Sandbar sharks can be distinguished from similar species by the sandbar shark's high and triangular dorsal fin.

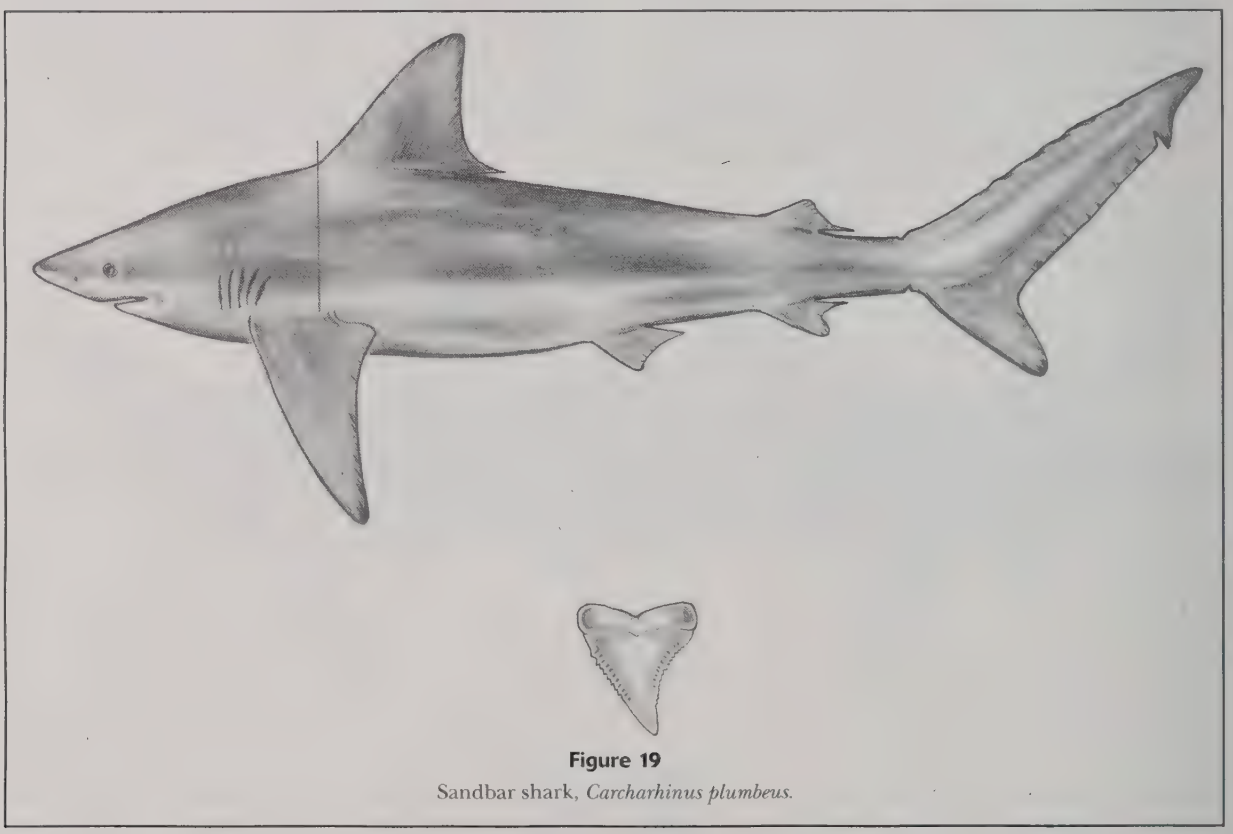


Figure 19
Sandbar shark, *Carcharhinus plumbeus*.

Bignose shark, *Carcharhinus altimus* (Fig. 20)

Interdorsal ridge present. First dorsal fin origin over pectoral fin inner margin; sometimes first dorsal fin origin is anterior to pectoral fin axil (Castro, 1983; Compagno, 1984). Snout long and moderately or sharply rounded; snout length generally equal to or greater than mouth width; Garrick (1982) reports a specimen with the snout length less than mouth width. Prominent nasal lobes. Pectoral fins long and broad. Upper teeth long, broad and serrated. Dental formula: 15–1 or 2–15/14–1–14 (Springer, 1950, and Hubbel[15] from examination of 6 jaw sets). Body gray above and white below. A green sheen is reported (Jensen[16]) along the gill area in freshly captured specimens. Maximum size: 282.0 cm TL (Springer, 1950); 162.0 cm TL and 200.0 cm TL estimated (NMFS, $n = 3$). Range: from Florida south to the north coast of South America in the Caribbean, including the Gulf of Mexico; a capture was documented off New Jersey (Grace and Henwood, 1997) with identification verified by examination of teeth (Hubbel[15]). Habitat: outer continental shelf to 423 m depth (Castro, 1983). The bignose shark shares a number of features with the night shark and these two species can be difficult to separate. Both sharks have the dorsal fin origin over the pectoral fin inner margin and they have long snouts that are moderately or sharply rounded. The most useful feature for distinguishing bignose sharks from night sharks is teeth; teeth of the bignose shark do not have a distinct notch with prominent basal serrations as found in the night shark. Another feature can be useful for separating bignose and night sharks: on night sharks the second dorsal fin free rear tip is at least twice the length of the second dorsal fin height (Garrick, 1985). Garrick (1982) considered the prominent nasal lobes (fleshy fold covering a portion of the nostril; also referred to as the anterior nasal flap by Compagno, 1984) and the long, broad, and serrated upper teeth on bignose sharks useful features for distinguishing bignose sharks from night sharks, Galapagos sharks, dusky sharks, and sandbar sharks.

[15] Hubbel, G. 1997. Jaws International, 150 Buttonwood Dr., Key Biscayne, FL 33149. Personal commun.

[16] Jensen, C. 1997. South Atlantic and Gulf of Mexico Fisheries Foundation, 5401 W. Kennedy Blvd., Suite 997, Tampa, FL 33609. Personal commun.

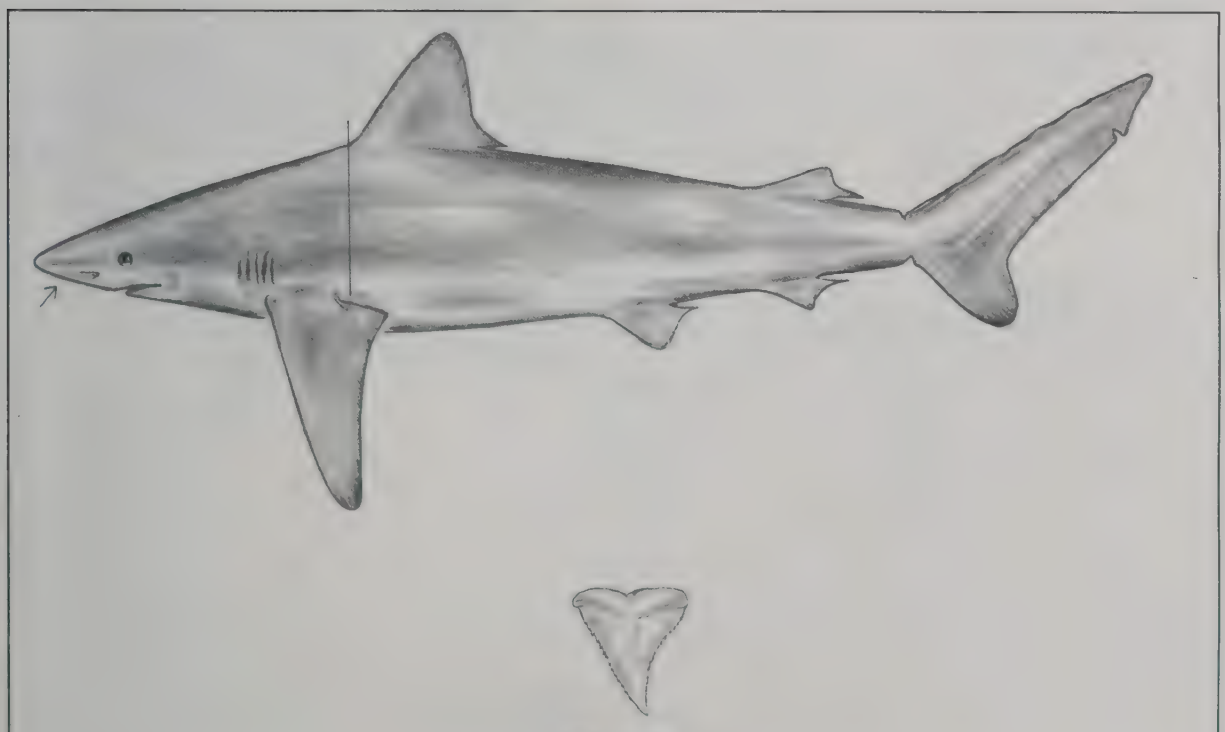


Figure 20
Bignose shark, *Carcharhinus altimus*.

Night shark, *Carcharhinus signatus* (Fig. 21)

Interdorsal ridge present. First dorsal fin origin over pectoral fin inner margin; sometimes first dorsal fin origin is posterior to pectoral fin inner corner (Castro, 1983). First dorsal fin low with apex angular or slightly rounded. Second dorsal fin free rear tip usually twice the length of the second dorsal fin height (Garrick, 1985). Snout long and sharply rounded; snout length equal to or greater than mouth width. Broad upper teeth with prominent basal serrations; distinct notch along margin and oblique cusps. Dental formula: 15–1 or 2–15/ 15–1–15 (Bigelow and Schroeder, 1948); tooth redrawn from Garrick (1985). Body gray blue above and white below; may have scattered dark spots along body (Garrick, 1982). The horizontal diameter of the eyes is half the length of the first gill slit (Guitart, 1974). Green eye color is frequently reported but this is not a consistent distinguishing feature. Maximum size: 276.6 cm TL (Bigelow and Schroeder, 1948); 255.0 cm TL (Raschi et al., 1982). Range: from Delaware south including the Bahamas and the north (Bigelow and Schroeder, 1948) and south coast of Cuba (Compagno, 1984), and parts of the Gulf of Mexico (Boschung, 1979; Branstetter, 1981). Habitat: outer continental shelf and beyond, from 50 m to 600 m depth (Compagno, 1984); Bigelow and Schroeder (1948) report a specimen from 26 m depth; Raschi et al. (1982) summarized the general distribution as between 199 m to 600 m; Branstetter (1981) reported a specimen captured with pelagic longline over a bottom depth of 2000 m in the northern Gulf of Mexico. The night shark can be confused with the bignose shark and it is recommended that teeth be examined; the bignose shark lacks the notched margin and prominent basal serrations found on night shark teeth. In addition, the night shark has a long second dorsal fin free rear tip usually twice the length of the second dorsal fin height; the bignose shark does not have a long second dorsal free rear tip (Garrick, 1982). Night sharks can be confused with silky sharks but the night shark's snout is long and sharply rounded; the silky shark's snout is of moderate length and moderately rounded. Teeth of silky sharks do not have prominent basal serrations as is typical for night sharks. Species account and illustration adapted from Bigelow and Schroeder, 1948; Krumholz, 1957; Guitart, 1974; Branstetter, 1981; Garrick, 1982, 1985; Raschi et al., 1982; Castro, 1983; Compagno, 1984. Some of the information in the species account and details used in the illustration were confirmed by examining a night shark specimen collected July 2000 from the north-central Gulf of Mexico (81.0 cm TL male, specimen provided by Cortes[10]; specimen archived by Neer[17]).

[17] Neer, J. 2000. Coastal Fisheries Institute, Louisiana State University, Baton Rouge, LA 70803-7503. Personal commun.

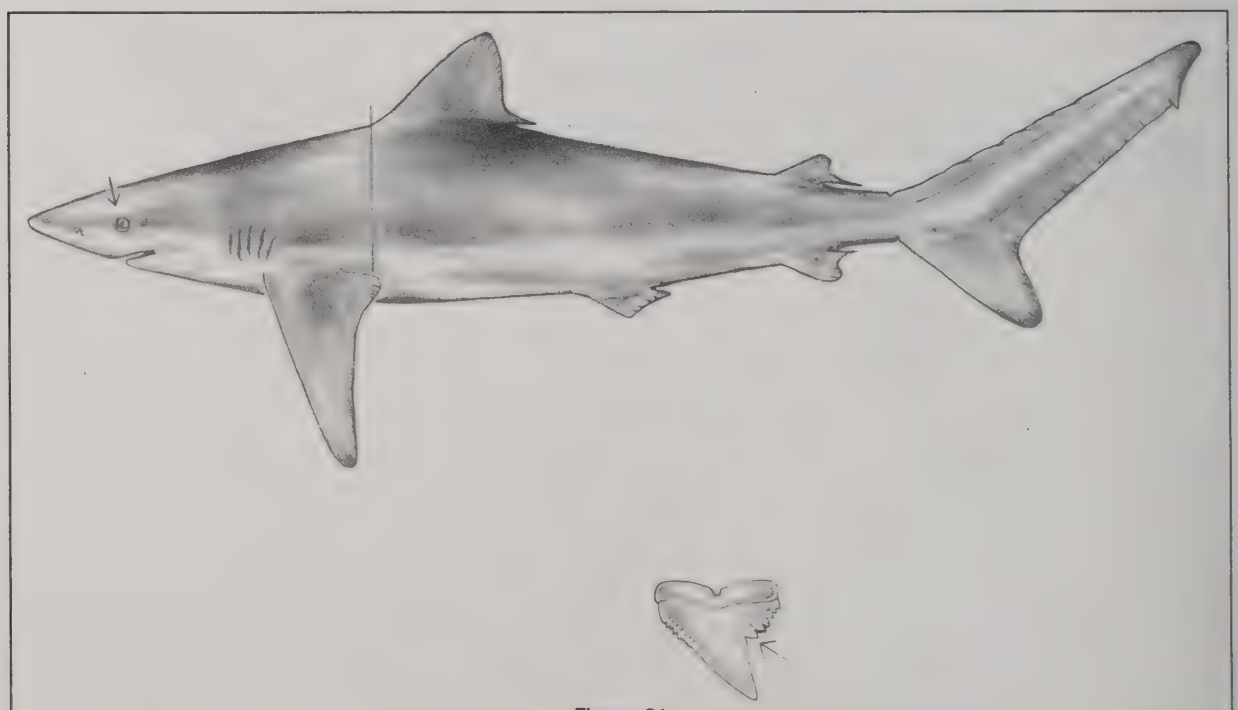


Figure 21
Night shark, *Carcharhinus signatus*.

Galapagos shark, *Carcharhinus galapagensis* (Fig. 22)

Interdorsal ridge present. First dorsal fin origin over pectoral fin inner margin; usually closer to pectoral fin inner margin midpoint than pectoral fin inner corner. Snout bluntly rounded; snout length less than mouth width. Upper teeth broad and serrated. Pectoral fins broad and long, not distinctly falcate along rear margins. Dental formula: 14–1–14/14–1–14 (Garrick, 1982) and upper jaw 15–1–14 (Skomal[18]). Body color is gray brown or brown above and white below. Maximum size: 292.1 cm TL (Randall, 1963). Range: from Bermuda and the Virgin Islands, rare along the U.S. continental coast; a capture was reported off of the U.S. eastern seaboard (Casey[19]). Habitat: oceanic islands often in areas with rock and coral bottoms, but can cross open ocean. Can be confused with the dusky shark and the reef shark. Generally, dusky sharks are distributed along continental coasts and usually have the first dorsal fin origin over or posterior to the pectoral fin inner corner and a pectoral fin with a falcate rear margin. The distribution of Galapagos sharks can overlap with the distribution of the reef sharks and it may be necessary to examine teeth to make an accurate identification since the first dorsal fin origin is similar. Teeth for the Galapagos shark have broader cusps than the more narrow cusps on the reef shark. The pectoral fins for the Galapagos shark are long and broad; for the reef shark the pectoral fins are long and tapered. Species account and illustration adapted from Randall, 1963; Garrick, 1982; Castro, 1983; Compagno, 1984.

[18] Skomal, B. 1997. Massachusetts Division of Marine Fisheries, P.O. Box 9, Vineyard Haven, MA 02568. Personal commun.

[19] Casey, J. 1985. Cruise results for Polish R/V Wieczno survey of apex predators, sharks and swordfish. Narragansett Laboratory cruise report, 8 p., 28 Tarzwell Dr., Narragansett, RI 02882-1199.

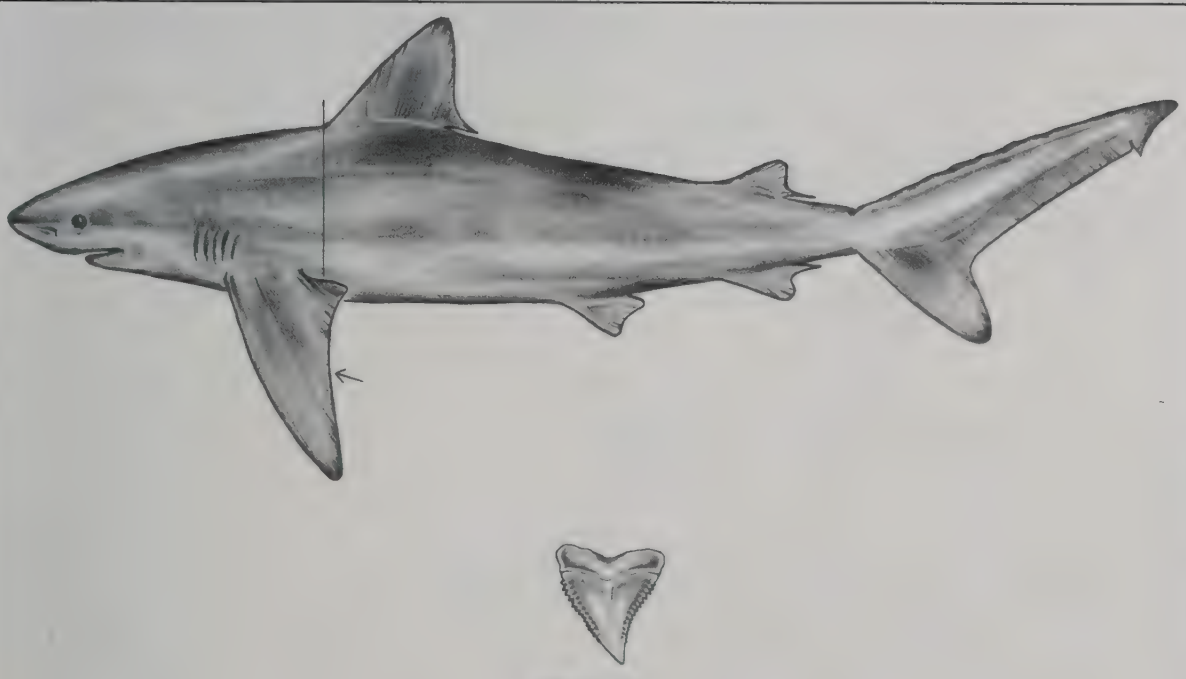


Figure 22

Galapagos shark, *Carcharhinus galapagensis*.

Dusky shark, *Carcharhinus obscurus* (Fig. 23)

Interdorsal ridge present. First dorsal fin origin over pectoral fin inner margin and generally closer to the inner margin corner than the inner margin midpoint; sometimes first dorsal fin origin is posterior to pectoral fin inner corner (Bigelow and Schroeder, 1948). First dorsal fin low and moderately rounded at apex. Pectoral fins long and tapered with falcate rear margins. Snout bluntly rounded; length generally less than or equal to mouth width; Garrick (1982) reports a specimen with snout length greater than mouth width. Upper teeth broad and serrated. Dental formula: 14 or 15–1 to 3–14 or 15/ 14–1 to 3–14 (Bigelow and Schroeder, 1948). Body gray, gray blue or gray brown above and white below. Maximum size: 367.8 cm TL (Springer, 1960; measurement converted from fork length with conversion from Kohler et al., 1996); 279.8 cm TL (Natanson, 1995; measurement converted from fork length with conversion from Kohler et al., 1996); 330.0 cm TL (Kohler et al., 1996); 220.0 cm TL estimated (NMFS, n = 4). Range: from George's Bank, Massachusetts south, including the Gulf of Mexico and Caribbean; reports of captures from the Bahamas and Bermuda may not be accurate (Garrick, 1982). Habitat: along continental coasts and occasionally to 400 m depth (Compagno, 1984). Dusky sharks can be confused with silky sharks (*Carcharhinus falciformis*), but dusky sharks have pectoral fins with falcate rear margins and teeth without distinct notches; silky sharks do not have pectoral fins with falcate rear margins and have teeth with distinct notches. The reef shark can closely resemble the dusky shark and it can be difficult to distinguish the two without examining teeth and pectoral fins; reef sharks have moderately narrow teeth and long and tapered pectoral fins without falcate rear margins. Dusky sharks can be confused with the Galapagos shark because of their similar shaped teeth but Galapagos sharks have long and broad pectoral fins without falcate rear margins and are typically distributed along oceanic islands.

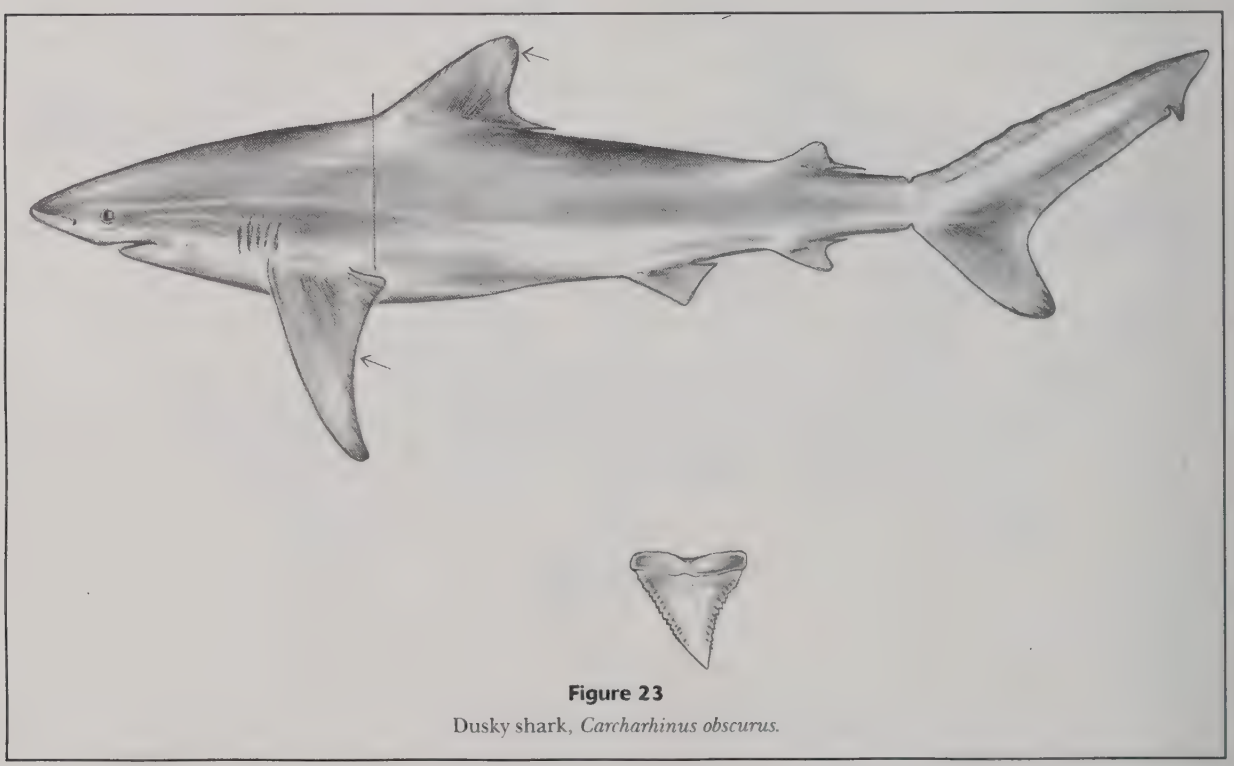


Figure 23
Dusky shark, *Carcharhinus obscurus*.

Reef shark, *Carcharhinus perezi* (Fig. 24)

Interdorsal ridge present. First dorsal fin origin over pectoral fin inner margin. Snout bluntly rounded; snout length less than mouth width. Upper teeth moderately narrow and serrated. Long and tapered pectoral fins. Dental formula: 12 or 13–1 or 2–12 or 13/ 11 or 12–1–11 or 12 (Garrick, 1982). Body gray or gray brown above and yellowish or white below. Underside of pectoral fin tips, pelvic fins tips, anal fin tip and the tip of lower caudal fin lobe often pigmented dusky or nearly black. Maximum size: 295.0 cm TL (Garrick, 1982); 201.0 cm TL (NMFS, $n = 3$). Range: from Bermuda and Florida south, including the Bahamas, Gulf of Mexico, and most of the Caribbean. Habitat: shallow coastal waters to 30 m depth, coral reefs and coral reef drop offs (Castro, 1983; Compagno, 1984). Can resemble the Galapagos shark and the dusky shark, and it may be necessary to examine teeth for an accurate identification. Upper teeth for reef sharks are moderately narrow and serrated, for Galapagos and dusky sharks upper teeth are broad and serrated. Pectoral fins for reef sharks are long and tapered; for Galapagos sharks pectoral fins are long and broad; for dusky sharks pectoral fins are long and tapered with falcate rear margins.

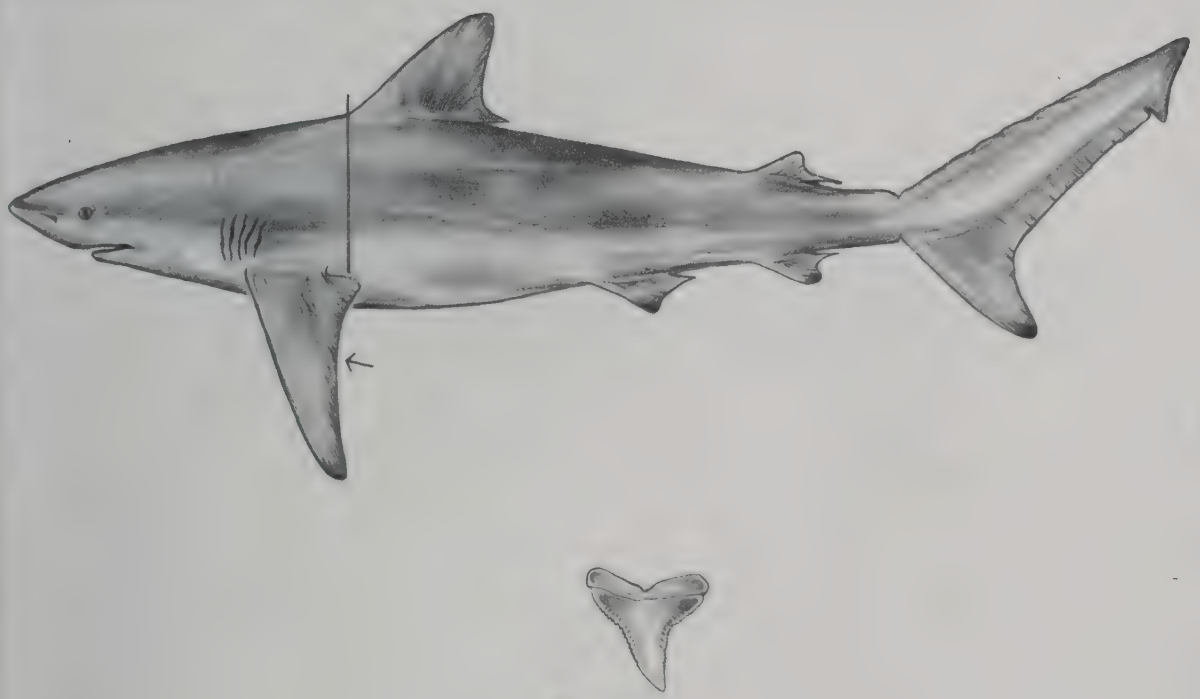


Figure 24
Reef shark, *Carcharhinus perezi*.

Silky shark, *Carcharhinus falciformis* (Fig. 25)

Interdorsal ridge present. First dorsal fin origin posterior to pectoral fin inner corner. First dorsal fin low with a moderately rounded apex. Second dorsal fin with a long free rear tip at least twice as long as second dorsal fin height. Pectoral fin length can vary from relatively short and broad (especially for specimens less than 1 m) to long and tapered for larger specimens; Garrick et al. (1964) reviews ontogenetic changes in various morphometric features. Snout moderately rounded; snout length generally less than mouth width; Garrick (1982) reports a specimen with snout length greater than mouth width. Upper teeth serrated and moderately broad with a notch on each lateral margin; lower teeth smooth. Dental formula: 15–2–15/15–1–15 (Garrick, 1982). Body is dark gray or gray brown above and white below; often the skin of freshly-caught specimens appears to have a silky sheen. Maximum size: 330.0 cm TL (Garrick et al., 1964); 267.0 cm TL (Branstetter, 1987b); 314.0 cm TL (Bonfil et al., 1993); 212.0 cm TL (NMFS, $n = 38$). Range: from Massachusetts south, including the Bahamas, Gulf of Mexico, and Caribbean. Habitat: coastal in 18 m depth to open ocean in 500 m depth, including deepwater reefs (Compagno, 1984). The teeth notched on each lateral margin, a long-tapered pectoral fin without a distinctly falcate rear margin, and a moderately rounded snout distinguishes silky sharks from dusky sharks. Unlike night sharks, silky sharks do not have an eye diameter one half the length of the first gill slit (the silky shark's eye is smaller) and teeth with basal serrations. In addition, the night shark's snout is long and sharply rounded.

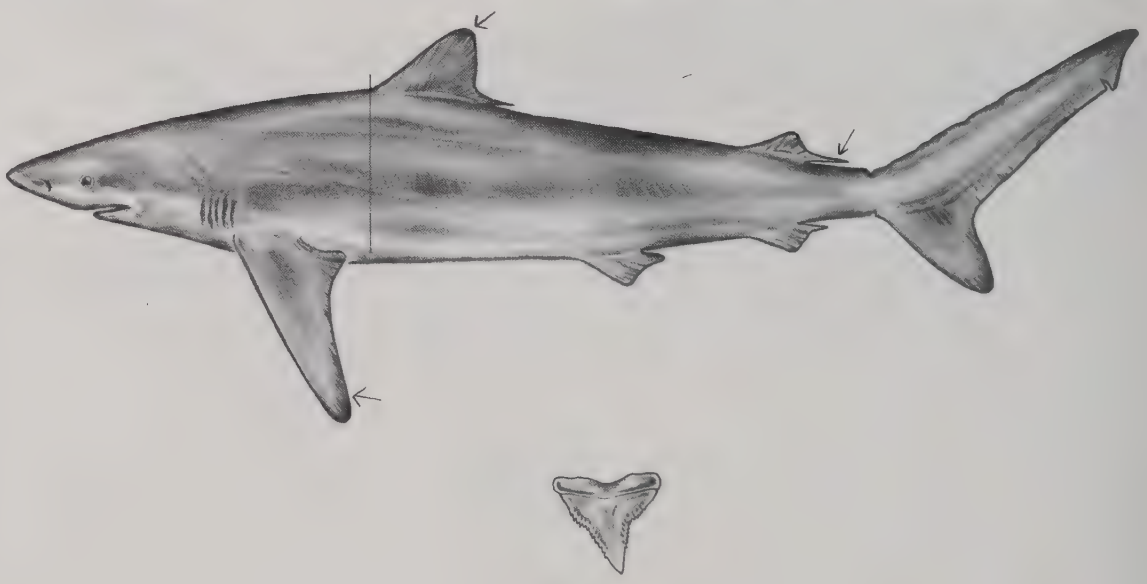


Figure 25
Silky shark, *Carcharhinus falciformis*.

Acknowledgments

This guide is as much a new field method for carcharhinid identifications as it is a summary of observations from a number of sources. The debt to those whose works for Carcharhinidae that preceded this document is respectfully acknowledged.

Several scientists have contributed valuable advice, information, specimens, photographs, support, or expertise needed to complete this guide and their efforts are appreciated. Among these scientists are Joanne Lyczkowski-Shultz, Scott Nichols, Terry Henwood, Lisa Jones, Perry Thompson, David Hanisko, Karen Mitchell, Denise Drass, Sally Glynn, and Wil Seidel, NMFS, Mississippi Laboratories; Enric Cortes, John Carlson, Lee Trent, and Mel Miller, NMFS, Panama City Laboratory; Wes Pratt, Lisa Natanson, and Nancy Kohler, NMFS, Narragansett Laboratory; Jack Casey, Chuck Stillwell, and Alan Lintala formerly with NMFS, Narragansett Laboratory; William Richards, Jose Castro, and Cheryl Brown, NMFS, Miami Laboratory; Liz Scott Denton and David LeDeaux, NMFS, Galveston, Texas; Brent Winner, Florida Department of Environmental Protection, St. Petersburg, Florida; Ash Bullard, University of Southern Mississippi-GCRL, Ocean Springs, Mississippi; George Benz, Chattanooga Aquarium, Chattanooga, Tennessee; Dario Guitart-Manday, University of Habana, Habana, Cuba; Leonel Espinosa, Centro de Investagaciones Pesqueras, Habana, Cuba; Leonardo Castillo and Alejandro Cid del Prado, Instituto Nacional de la Pesca, Mexico City, Mexico; Greg Skomal, Massachusetts Division of Marine Fisheries; Erich Ritter, Green Marine, Miami, Florida; Phil Heemstra, JLB Smith Institute of Ichthyology, Grahamstown, South Africa; Steve Branstetter, NMFS Southeast Regional Office, St. Petersburg, Florida; Captain Jimmy Reahard, Pascagoula, MS; Chris Jensen, Gulf and South Atlantic Fisheries Development Foundation, Tampa, Florida; Gordon Hubbel, Jaws International, Key Biscayne, Florida; Terry Cody and Paul Choucair, Texas Parks and Wildlife, Rockport, Texas; Charles Manire and John Tyminski, Mote Marine Laboratory, Sarasota, Florida; Trey Driggers, Univ. of South Carolina, Columbia, South Carolina. Special thanks are extended to my family, Suzanne Grace, Erin Grace, and Kyla Grace; the command and crew of NOAA Ships *Oregon II, Chapman, Relentless* (renamed the *Gordon Gunter*), *Ferrel, Delaware II*, NMFS RV *Caretta*; UNOLS RV *Pelican*; commercial fishing vessels *Captain Grumpy, Persistence*, and *Old Colony*; Japanese fishing vessel *Nisshin Maru No. 201.*

Literature cited

Backus, R. H., S. Springer, and E. L. Arnold Jr.
1956. A contribution to the natural history of the white-tip shark, *Pterolamiops longimanus* (Poey). Deep-Sea Res., Vol. 3:178–188.

Baughman, J. L., and S. Springer.
1950. Biological and economic notes on the sharks of the Gulf of Mexico, with especial reference to those of Texas, and with a key for their identification. Am. Midl. Nat., Univ. of Notre Dame, Notre Dame, IN, 44(1):96–152.

Bigelow, H. B., and W. C. Schroeder.
1948. Fishes of the western North Atlantic. Mem. Sears Found. Mar. Res., Yale Univ., Part 1, 576 p.

Bonfil, R.
1994. Overview of world elasmobranch fisheries. FAO Fish. Tech. Paper (341), 119 p.

Bonfil, R., R. Mena, and D. de Anda.
1993. Biological parameters of commercially exploited silky sharks, *Carcharhinus falciformis*, from the Campeche Bank, Mexico. *In* S. Branstetter (ed.), Conservation of elasmobranches, p. 73–86. NOAA Tech. Rep. NMFS 115.

Boschung, H. T., Jr.
1979. The sharks of the Gulf of Mexico. Nature Notebook. Alabama Mus. Nat. Hist. No. 4, 16 p.

Branstetter, S.
1981. Biological notes on the sharks of the north central Gulf of Mexico. Contrib. Mar. Sci. 24:13–34.
1982. Problems associated with the identification and separation of the spinner shark, *Carcharhinus brevipinna*, and the blacktip shark, *Carcharhinus limbatus*. Copeia 1982(2):461–465.
1987a. Age and growth estimates for blacktip, *Carcharhinus limbatus*, and spinner, *C. brevipinna*, sharks from the Northwestern Gulf of Mexico. Copeia 1987(4):964–974.
1987b. Age, growth and reproductive biology of the silky shark, *Carcharhinus falciformis*, and the scalloped hammerhead, *Sphyrna lewini*, from the Morthwestern Gulf of Mexico. Environ. Biol. Fishes 19(3):161–173.

Branstetter, S., and R. Stiles.
1987. Age and growth estimates of the bull shark, *Carcharhinus leucas*, from the northern Gulf of Mexico. Environ. Biol. Fishes 20(3):169–181.

Casey, J. G.
1964. Anglers' guide to sharks of the northeastern United States, Maine to Chesapeake Bay. Bureau of Sport Fisheries and Wildlife Circ. 179, 32 p.

Castro, J. I.
1983. The sharks of North American waters. Texas A&M University Press, College Station, Texas, 180 p.
1993. Biology of the finetooth shark, *Carcharhinus isodon*. Environ. Biol. Fishes 36:219–232.

Clark, E., and K. von Schmidt.
1965. Sharks of the central Gulf Coast of Florida. Bull. Mar. Sci. 15:13–83.

Compagno, L. J. V.
1984. Sharks of the world. FAO Fisheries Synop. No. 125, Vol. 4, Part 2 (Carcharhiniformes), p. 251–655.
1988. Sharks of the order Carcharhiniformes. Princeton Univ. Press, Princeton, NJ, 486 p.

Garman, S.
1997. The Plagiostomia (sharks, skates and rays). Benthic Press, Los Angeles, CA, 511 p.

Garrick, J. A. F.
1982. Sharks of the genus *Carcharhinus*. NOAA Tech. Rep. NMFS Circ. 445, 194 p.
1985. Additions to a revision of the shark genus *Carcharhinus*: synonymy of *Aprionodon* and *Hypoprion*, and description of a new species of *Carcharhinus* (Carcharhinidae). NOAA Tech. Rep. NMFS 34, 26 p.

Garrick, J. A. F., R. H. Backus, and R. H. Gibbs Jr.
1964. *Carcharhinus floridanus*, the silky shark, a synonym of *C. falciformis*. Copeia 2:369–375.

Grace, M., and T. Henwood.
1997. Assessment of the distribution and abundance of coastal sharks in the U.S. Gulf of Mexico and eastern seaboard, 1995 and 1996. Mar. Fish. Rev. 59(4):23–32.

Gruber, S. H., and R. G. Stout.
1983. Biological materials for the study of age and growth in a tropical marine elasmobranch, the lemon shark, *Negaprion brevirostris* (Poey). *In* E. Prince and L. Pulos (eds.), Proceedings of the international workshop on age determination of oceanic fishes; tunas, billfishes and sharks, p. 193–205. NOAA Tech. Rep. NMFS 8.

Guitart, D. J.
1974. Sinopsis de los peces marinos de Cuba. Academia de Ciencias de Cuba, Instituto de Oceanologia, Habana, Cuba, Vol. 1 (Tomo 1).

Heemstra, P. C.
1997. A revision of the smooth-hound sharks (Genus *Mustelus*, Family Triakidae) of the western Atlantic Ocean, with descriptions of two new species and a new subspecies. Bull. Mar. Sci. 60(3):894–928.

Hoese, H. D., and R. H. Moore.
1977. Fishes of the Gulf of Mexico, Texas, Louisiana, and adjacent waters. Tex. A&M Univ. Press, College Station, 327 p.

Kohler, N. E., J. G. Casey, and P. A. Turner.
1996. Length-length and length-weight relationships for 13 shark species from the western North Atlantic. NOAA Tech. Memo. NMFS-NE-110, 22 p.

Krumholz, L. A.
1957. A record of the night shark, *Hypoprion signatus*, from Bimini, Bahamas. Copeia 1957:300–301.

Lessa, R., V. Batista, and Z. Almeida.
1999. Occurrence and biology of the daggernose shark, *Isogomphodon oxyrhynchus* (Chrondrichthyes: Carcharhinidae), off the Maranhao coast (Brazil). Bull. Mar. Sci. 64(1):115–128.

McEachran, J. D., and J. D. Fechhelm.
1998. Fishes of the Gulf of Mexico. Univ. of TX Press, Austin, TX, 1120 p.

Meek, S. E., and S. F. Hildebrand.
1923. The marine fishes of Panama. Field Mus. Natural Hist. Publ. No. 215, Vol. XV, Part I, p. 53–56.

Natanson, L. J.
1995. Age and growth estimates for the dusky shark, *Carcharhinus obscurus*, in the western North Atlantic Ocean. Fish. Bull. 93(1):116–126.

Parsons, G. R.
1985. Growth and age estimates of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*: A comparison of techniques. Copeia 1985(1):80–85.

Pratt, H. L.
1979. Reproduction in the blue shark, *Prionace glauca*. Fish. Bull. 77(2):445–470.

Randall, J. E.
1963. A fatal attack by the shark *Carcharhinus galapagensis* at St. Thomas, Virgin Islands. Carib. J. Sci. 3(4):201–205.

Raschi, W., J. A. Musick, and L. J. V. Compagno.
1982. *Hypoprion bigelowi*, a synonym of *Carcharhinus signatus* (Pisces: Carcharhinidae), with a description of ontogenetic heterodonty in this species and notes on its natural history. Copeia 1982:102–109.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott.
1991. Common and scientific names of fishes from the United States and Canada. Am. Fish. Soc. Spec. Publ. 20, 183 p.

Schwartz, F. J.
1984. Occurrence, abundance, and biology of the blacknose shark, *Carcharhinus acronotus*, in North Carolina. Northeast Gulf. Sci. 7(1):29–47.

Schwartz, F. J., and G. H. Burgess.
1975. Sharks of North Carolina and adjacent waters. Inf. Ser. N.C. Dep. Nat. Econ. Resour. Div. Mar. Fish., 57 p.

Springer, S.
1950. A revision of North American sharks allied to the genus *Carcharhinus*. Am. Mus. Novit. 1451, 13 p.
1960. Natural history of the sandbar shark. U.S. Fish Wild. Serv., Fish. Bull. 61(178):1–38.

Springer, S., and J. R. Thompson.
1957. Night sharks, *Hyproprion*, from the Gulf of Mexico and Straits of Florida. Copeia 1957:160.

Springer, V. G.
1964. A revision of the Carcharhinid shark genera *Scoliodon*, *Loxodon* and *Rhizoprionodon*. Proc. U.S. Natl. Mus., No. 3493, 115:559–632.

Uyeno, T., and T. Sasaki.
1983. Carcharhindae. *In* T. Uyeno, K. Matsuura, and E. Fujii (eds.), Fishes trawled off Suriname and French Guiana, p. 53–56. Japan Marine Fishery Resource Research Center.

NOAA Technical Reports NMFS

Technical Reports of the *Fishery Bulletin*

Guide for Contributors

Preparation

Title page should include authors' full names and mailing addresses and the senior author's telephone and FAX number.

Abstract should not exceed one double-spaced typed page. It should state the main scope of the research but emphasize its conclusions and relevant findings. Because abstracts are circulated by abstracting agencies, it is important that they represent the research clearly and concisely.

Text must be typed double-spaced throughout. A brief introduction should portray the broad significance of the paper; the remainder of the paper should be divided into the following sections: **Materials and methods, Results, Discussion** (or **Conclusions**), and **Acknowledgments**. Headings within each section must be short, reflect a logical sequence, and follow the rules of multiple subdivision (i.e. there can be no subdivision without at least two items). The entire text should be intelligible to interdisciplinary readers; therefore, all acronyms, abbreviations, and technical terms should be spelled out the first time they are mentioned. The scientific names of species must be written out the first time they are mentioned; subsequent mention of scientific names may be abbreviated. Follow the *U.S. Government Printing Office Style Manual* (1984 ed.) and the *CBE Style Manual* (5th ed.) for editorial style, and the most current issue of the *American Fisheries Society's Common and Scientific Names of Fishes from the United States and Canada* for fish nomenclature. Dates should be written as follows: 11 November 1991. Measurements should be expressed in metric units, e.g., metric tons as (t); if other units of measurement are used, please make this fact explicit to the reader. The numeral one (1) should be typed as a one, not as a lower-case el (l).

Text footnotes should be numbered with Arabic numerals and typed on a separate sheet of paper. Footnote all personal communications, unpublished data, and unpublished manuscripts with full address of the communicator or author, or, as in the case of unpublished data, where the data are on file. Authors are advised to avoid references to nonstandard (gray) literature, such as internal, project, processed, or administrative reports, wherever possible. Where these references are used, please include whether they are available from NTIS (National Technical Information Service) or from some other public depository.

Literature cited comprises published works and those accepted for publication in peer-reviewed literature (in press). Follow the name and year system for citation format. In the text, cite Smith and Jones (1977) or (Smith and Jones, 1977). If there is a sequence of citations, list chronologically: Smith, 1932; Green, 1947; Smith and Jones, 1985. Abbreviations of serials should conform to abbreviations given in *Serial Sources for the BIOSIS Previews Database*. Authors are responsible for the accuracy and completeness of all citations.

Tables should not be excessive in size and must be cited in numerical order in the text. Headings should be short but ample enough to allow the table to be intelligible on its own. All unusual symbols must be explained in the table heading. Other incidental comments may be footnoted with italic numerals. Use asterisks for probability in statistical data. Because tables are typeset, they need only be submitted typed and formatted, with double-spaced legends. Zeros should precede all decimal points for values less than one.

Figures include line illustrations and photographs (or slides) and must be cited in numerical order in the text. Unless photographs are submitted on glossy paper with good contrast, we cannot guarantee a good final printed copy. Figures are to be labeled with author's name and number of figure. Use Times Roman font (upper and lowercase letters) to label within figures. Avoid vertical lettering except for *y*-axis labels. Zeros should precede all decimal points for values less than one. Figures may be submitted as computer software files (along with laser-printed copies), as photo-mechanical transfers (PMTs), or as high quality photographic prints. Send only xerox copies of figures to the Scientific Editor; original figures will be requested later when the manuscript has been accepted for publication. Figure legends should explain all symbols and abbreviations and should be double-spaced on a separate page at the end of the manuscript.

Copyright law does not cover government publications; they fall within the public domain. If an author reproduces any part of a government publication in his work, reference to source is considered correct form.

Submission

Send printed copies (original and three copies) to the Scientific Editor:

Dr. John V. Merriner, Scientific Editor
Center for Coastal Fisheries and Habitat Research, NOS
101 Pivers Island Road
Beaufort, NC 28516

Once the manuscript has been accepted for publication, you will be asked to submit a software copy of your manuscript to the Managing Editor. The software copy should be submitted in WordPerfect or Word format and should be placed on a 3.5-inch disk that is double-sided, double or high density, and that is compatible with DOS/Windows systems. Note: We are no longer able to accept ASCII text files.

Copies of published reports (and articles within multi-authored reports) are available free of charge to the senior author (50 copies) and to his or her laboratory (50 copies). Additional copies may be purchased in lots of 100 when the author receives page proofs.

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS OFFICE
BIN C15700
SEATTLE, WA 98115
OFFICIAL BUSINESS

Penalty for Private Use, $300

PRSRT STD
POSTAGE & FEES PAID
U.S. DEPARTMENT OF COMMERCE
PERMIT NO. G-19

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 13, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

The major components of NOAA regularly produce various types of scientific and technical information in the following kinds of publications:

PROFESSIONAL PAPERS—Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS—Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS—Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS—Reports containing data, observations, instructions, etc. A partial listing includes data serials; predictions and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS—Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS—Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.

Information on availability of NOAA publications can be obtained from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

☆ U. S. GOVERNMENT PRINTING OFFICE: 2001-PROGRAM 2057-S/40001